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FORTY-FIRST ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

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1909.

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Chemist.

H. W. CLARK.

CONTENTS.

GENERAL REPORT.

In accordance with the provisions of chapter 211 of the Acts of 1905, the following report of the work of the several departments of the State Board of Health is presented for the fiscal year ended Nov. 30, 1909, on which date the Board was constituted as follows: —

HENRY P. WALCOTT, M.D., of Cambridge, *Chairman.*

ROBERT W. LOVETT, M.D., of Boston.	Hon. CHARLES H. PORTER of Quincy.
GERARD C. TOBEY, Esq., of Wareham.	JULIAN A. MEAD, M.D., of Watertown.
JAMES W. HULL of Pittsfield.	HIRAM F. MILLS, A.M., C.E., of Lowell.

On Jan. 7, 1909, at a regular meeting of the Board, Dr. Mark W. Richardson of Boston was elected secretary, and entered upon the duties of the office on Jan. 18, 1909. During the interval between the death of Dr. Harrington and the election of Dr. Richardson the duties of the office were performed by Dr. William C. Hanson, assistant to the secretary.

SLAUGHTERING OF NEAT CATTLE, SHEEP AND SWINE.

On June 3, 1909, the Legislature passed the following resolve: —

ACTS OF 1909, CHAPTER 118.

RESOLVE TO AUTHORIZE THE STATE BOARD OF HEALTH TO INVESTIGATE THE SLAUGHTERING OF NEAT CATTLE, SHEEP AND SWINE.

Resolved, That the state board of health is hereby authorized and directed to investigate the methods and circumstances of the slaughtering of neat cattle, sheep and swine and the inspection of the products thereof, and the operation of chapter five hundred and thirty-seven of the acts of the year nineteen hundred and seven and the acts in amendment thereof and in addition thereto, and to report the result of its investigation to the general court on or before January fifteenth next, with such recommendations as the board may deem advisable. [*Approved June 3, 1909.*

The report called for follows: —

By chapter 118 of the Resolves of 1909 the State Board of Health was directed to —

investigate the methods and circumstances of the slaughtering of neat cattle, sheep and swine and the inspection of the products thereof, and the operation of chapter

five hundred and thirty-seven of the acts of the year nineteen hundred and seven and the acts in amendment thereof and in addition thereto, and to report the result of its investigation to the general court on or before January fifteenth next, with such recommendations as the board may deem advisable.

Acting in accordance with the provisions of the above resolve, the Board found that some of the laws relative to slaughtering were very generally ignored.

Section 99 of chapter 75 of the Revised Laws provides that the proprietor of every slaughterhouse shall apply annually, in April, to the local authorities for a license, stating in his application, which must be in writing and properly sworn to, the estimated number of animals to be slaughtered per week and the days of the week upon which they are to be slaughtered; and yet an investigation made by the Board disclosed the fact that 70 persons conducting the business of slaughtering failed to apply for a license. In 6 instances it was found not to be the custom to apply for a license until fall. In 6 towns it was found to be the policy of the local authority not to issue licenses to slaughter, and in 1 town meat inspection was conducted at the meat markets. Of the persons who applied to local authorities for licenses, 41 were refused. The chief reasons for refusing licenses appeared to be on account of previous illegal slaughtering, or because of an unsuitable place for slaughtering. Several licenses issued by local authorities were found not to conform to the statute requirements. Of the 111 proprietors of slaughterhouses found to hold no license for slaughtering, 55 were discovered in the act of slaughtering.

Section 101 of chapter 75 of the Revised Laws prohibits slaughtering on any days other than those specified in the application, except in the presence of a member of the board of health or of an inspector appointed for the purpose by the board; section 102 provides for the presence of the inspector and for examination of the carcasses at the time of slaughter. Section 106 provides a fine of not more than $500 or imprisonment for not more than sixty days, or both fine and imprisonment, for slaughtering without a license, or for neglecting to cause carcasses to be inspected, or for selling a carcass or part thereof that has not been inspected. Notwithstanding the above provisions, the State Inspectors of Health found 200 instances where neither a meat inspector nor a member of the board of health was present at the time of slaughter. In 16 towns where slaughtering was conducted the law was violated by failure to appoint a meat inspector. In 39 instances diseased carcasses were discovered by State Inspectors of Health and condemned at the time of slaughter, 29 in the absence of a local meat inspector and 10 in the presence of a local meat inspector. In one instance the carcass had been stamped.

One hundred and twenty-two carcasses were condemned by State Inspectors of Health in accordance with the statute requirements; 76 of this number were unstamped and 46 were diseased. In several instances diseased animals were found ready for slaughter.

In 215 instances the State Inspectors of Health found that it was the custom of the meat inspector, instead of being present at the time of slaughter, to call later on the same day; in 46 instances, on the same day or on the following day; in several instances, "when sent for," and in 6 instances, "not at all." In 116 instances evidence was found that the meat inspector was sent for previous to slaughtering, but that he did not appear until after slaughtering. In 39 instances this was a customary procedure. In 26 instances it was found that the meat inspector was not sent for until after slaughtering, and that, consequently, he was not present at the time of slaughter. In several instances it was discovered that it was not the custom for the meat inspector to go to the slaughterhouse unless notified that suspicious meat was detected. Thus it will be seen that in many cases carcasses were not legally inspected; consequently, they were not condemned, even though showing evidence of disease.

Other facts disclosed by the investigation are as follows: —

In at least 10 instances there was evidence that uninspected animals killed on unlicensed premises were brought to a licensed slaughterhouse to be dressed and inspected. In 3 instances meat that was condemned in one place was removed to another town and there inspected, passed and stamped. In 30 instances there was evidence that meat slaughtered in the absence of a meat inspector was inspected later *en route* or at the meat inspector's house. In 4 towns this was the general custom.

In at least 2 instances a licensee who was not the meat inspector was found using the meat inspector's stamp.

In more than 50 instances it was found to be the custom for the licensee, and not for the town, to pay for meat inspection.

In more than 15 instances it was found that the person appointed as meat inspector was the licensee. In 3 instances the inspector was the proprietor's foreman. In 5 instances the meat inspector was an unlicensed proprietor.

The qualifications of some of the meat inspectors were found to be as follows: —

In 102 towns the meat inspector was either a veterinarian, butcher or an experienced man, well qualified for his position; in 55 towns the meat inspector was a farmer; in 7, a marketman; in 3 towns, a cattle trader; and in 3 towns, a milk producer.

Facts concerning the qualifications of other men were found to be as follows: —

"No qualifications" in 33 towns; "not well qualified" in 4; "practising physicians" in 3; "qualifications fair" in 5; "aged, infirm men" in 2; while the following qualifications represent a meat inspector in each of 15 towns, respectively: —

Postmaster (formerly in meat business); clerk in employ of meat firm; shoemaker; unlicensed graduate in medicine; druggist; hotel keeper; driver of town watering cart; paper hanger; machinist; grocer; plumber; night watchman; optician; and real estate agent.

In making the investigation the State Inspectors of Health visited more than 70 of the larger slaughtering establishments. Of this number about one-third were distinctly objectionable, and 6 were conducting business without licenses. On the other hand, those establishments which in the main showed objectionable conditions were the small slaughterhouses situated in the country districts, there being some 160 which deserved the severest condemnation.

Thirty-two slaughtering places were found to be used for killing condemned cattle.

A separate building was found to be used for slaughtering in 190 instances. On the other hand, in 291 instances a part of a barn, stable or other building was used.

In 5 cities and 94 towns no slaughterhouse was found.

A study of the conditions observed by the State Inspectors of Health in slaughterhouses led to the division of these establishments into three distinct classes: (1) those which merit condemnation; (2) those which are reasonably satisfactory; (3) those which are distinctly objectionable. Of the 370 licensed slaughterhouses visited, 34 merited commendation, 219 were reasonably satisfactory and 117 were distinctly objectionable. Of the unlicensed slaughterhouses discovered, 17 were in good sanitary condition; while, on the other hand, 59 were distinctly objectionable.

In order that slaughtering establishments may be classified as satisfactorily conducted, the following conditions should be required: —

1. Preferably, a building somewhat isolated, used only for slaughtering purposes. Slaughtering may, however, be conducted in a portion of a building which is properly separated and securely partitioned from other sections of the building.

(*a*) The slaughter room should be so constructed that walls and floor can be kept clean. The sides of the room, for a height of 6 feet or thereabouts, should be constructed of such material that they may be kept clean and free from blood, manure and filth of any sort. The floor should be tight and even, so constructed (*e.g.*, drained toward center of room) that it may be easily and thoroughly scraped and washed with scalding water.

(*b*) Some means should be provided for prompt and proper removal of blood, waste meat and other refuse matter. Drainage water should go to sewers, or, in the absence of a sewerage system, through pipes properly trapped to covered cesspools located at some distance from the building.

(*c*) Doors and windows should be screened in the fly season.

(*d*) Provision should be made for proper washing facilities and water-closets.

(*e*) Hooks, trimming boards or shelves, poles and other conveniences should be washed with hot water after each usage, and all utensils should be kept clean.

(*f*) Knives and other instruments used on diseased animals or diseased portions of animals should be sterilized in boiling water containing washing

soda for five minutes before they are used again. (Few butchers keep their instruments clean. It is not an uncommon practice to cut into a tubercular gland, and then continue to dress the carcass with the same knife without first cleaning it.)

(*g*) A suitable meat room or cooler should be provided, and should be kept clean. (Meat should not be hung in a slaughterhouse until taken to market.)

(*h*) The room for slaughtering should not be used as a tie-up for animals awaiting slaughter.

(*i*) Animals condemned because of disease should not be slaughtered in the same place where animals are slaughtered for food.

(*j*) Cans for refuse matter should be of metal, and provided with covers.

2. An abundant supply of ice and of pure water, preferably running water, hot and cold, should be provided.

3. The meat inspection and slaughtering rooms should be well lighted and adequately ventilated, and there should be a suitable place for the meat inspectors to examine the viscera.

4. If there is a cellar, it should be kept dry and clean.

5. The yard and surroundings should be kept clean.

Report upon the Investigation relative to the Treatment of Rabies.

On May 3, 1909, the following resolve relative to the treatment of rabies was approved by His Excellency Governor Draper: —

Resolves of 1909, Chapter 72.
Resolve relative to the Treatment of Rabies.

Resolved, That the state board of health shall cause suitable provision to be made for the treatment of rabies in man by appropriate remedies, and shall report to the next general court, on or before the tenth day of January, as to the expense and advisability of preparing these remedies under the direction of the state board of health. [*Approved May 3, 1909.*

In reply to the question submitted, the State Board of Health has the honor to submit the following: —

Since 1904 rabies has been unusually prevalent in the Commonwealth, as will be seen when it is stated that whereas in 1904 there was no case of rabies in animals, in either dogs, cattle, horses, pigs, cats or goats, in 1905 there were 103 cases; in 1906, 337 cases; in 1907, 778 cases; in 1908, 557 cases; and in 1909, up to December 1, 168 cases.

As to the number of human beings bitten by rabid animals, there were, in 1905, 12 cases; in 1906, 101 cases; in 1907, 184 cases; in 1908, 134 cases; and in 1909, up to October 27, 77 cases. During the period 1905 to 1909, inclusive, 19 human beings died of rabies.

It is, therefore, apparent that the disease in the present epidemic reached its maximum in 1907, and is now on the decrease.

As regards methods pursued in the treatment of those infected with rabies, a large percentage of cases has been treated either at the State Almshouse at Tewksbury, at the Boston City Hospital or at the Pasteur Institute in New York. For instance, in 1906, 60 cases; in 1907, 78 cases; in 1908, 69 cases; and in 1909, 39 cases were treated at these institutions. The other cases were treated, in most instances, by agents of local boards of health. The inoculation material for use within the State has been secured from the New York City board of health. The expense has been $20 per case. Treatment at the Pasteur Institute in New York is considerably more expensive.

If the matter of supplying inoculation material and treatment to citizens of the Commonwealth were placed under the direction of the State Board of Health, one of three different plans might be pursued: —

1. The inoculation material might be manufactured, distributed and applied by agents of the Board;

2. The inoculation material might be purchased from the New York City board of health and applied by agents of this Board; or

3. The inoculation material might be procured free of charge from the Public Health and Marine-Hospital Service in Washington, and applied by regular agents of this Board under its supervision.

Inquiry reveals the fact that to manufacture, distribute and apply rabies virus by the Board would cost at least $5,000 a year. If the material were purchased, the cost would vary manifestly with the number of cases.

In view of the fact that the Public Health and Marine-Hospital Service is prepared to furnish, for the present at least, rabies virus to State boards of health under satisfactory conditions and free of expense, the best method of solving this problem through the State Board of Health would seem to be to secure from the Public Health and Marine-Hospital Service such virus as is necessary, and have it distributed and applied by special agents under the direction of the Board. Under this arrangement the annual expense should not be more than $2,000 per year, except in the presence of a marked epidemic.

Water Supply and Sewerage.

The State Board of Health presents herewith a report of its doings for the twelve months ended Nov. 30, 1909, under the provisions of laws relating to the protection of the purity of inland waters, as required by chapter 75, section 115, of the Revised Laws.

The Board has received during the year 128 applications for advice with reference to water supply, sewerage, sewage disposal and matters relating thereto. Of these applications, 88 were in relation to water supply, 6 to sources of ice supply, 22 to sewerage, drainage and sewage-disposal systems, 9 to pollution of streams, and 3 to miscellaneous matters.

Water Supplies.

Public water supplies were introduced during the year in the towns of Bedford, Blandford, Pepperell and Plainville, and at the end of the year, of the 354 cities and towns in the State, 192 were provided with public water supplies. All of the cities and towns having a population according to the census of 1905 in excess of 3,500 are now provided with public water supplies, except the towns of Barnstable, Blackstone, Dartmouth, Dudley,[1] Templeton and Tewksbury. The cities and towns having public water supplies contain approximately 94 per cent. of the total population of the State.

New supplies were also introduced for the first time in the village of East Brookfield in the town of Brookfield, and in the village of Bondsville in the town of Palmer. These villages are widely separated from the central portions of the towns in which they are situated, and separate works were constructed in each case.

In addition to the towns and villages in which water was introduced for the first time in 1909, extensive additions were made to the sources of water supply in many other cities and towns. Most notable among these is the introduction of a new public water supply in the town of Easthampton, the water supply of which has hitherto been taken from Bassett Brook, a stream which has become inadequate for the supply of the town at all times, and is exposed to much danger of pollution from the very considerable population living within its watershed. Under advice of the Board an investigation was made for the purpose of obtaining a supply of water from the ground, and as a result of a thorough investigation, carried on under the direction of a committee appointed by the town, a supply of ground water was discovered in the valley of Broad Brook about a mile and a half southeast of the village, which yields by natural flow alone a quantity much greater than the town now requires.

An important addition was made to the water supply of Manchester by the introduction of water from Gravel and Round ponds, and extensive additions were also made to the water supplies of Cohasset, Newton, Woburn and other places. The town of Concord introduced for the first time a water supply from Nagog Pond, a source which had been granted to that town by the Legislature twenty-five years ago.

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[1] Water works under construction.

Towns without Public Water Supplies.

The cities and towns which are provided with a system of public water supply number, as stated above, 192, and contain 94 per cent. of the population of the State. In the remaining cities and towns the inhabitants are dependent on private supplies derived chiefly from wells situated usually in the immediate vicinity of dwelling houses. For the purpose of ascertaining the character of the water of such wells in thickly settled communities, samples of water from a number of wells in several of the towns which are not provided with public water supplies have been collected from time to time for analysis, and the surroundings of the wells have been carefully noted. In nearly all such cases the wells were found to be polluted by sewage in a greater or less degree, and in some cases the conditions have been found to be so serious that the introduction of a public water supply has been urged. Such was the case in the village of Fairview in the city of Chicopee, in which a public water supply is now being introduced.

The most seriously objectionable conditions thus far encountered have been in the village of Somerset on the easterly side of Mt. Hope Bay, opposite the northerly end of the city of Fall River. Samples of water were collected from a number of wells in that village in the latter part of 1907, and, the results having shown that the water was very badly polluted, the Board, in a communication to the town, expressed the opinion that the use of water from these wells should be prevented, and called attention to the need of a general system of water supply in this village. Nothing having been done, however, a further examination of the water of these wells was made in the latter part of 1909, and, the results showing that practically all of these wells were grossly polluted by sewage and the character of the water such as to be likely to be very injurious to the health of those who used it for drinking, the Board has again recommended that steps be taken by the town without further delay to provide an adequate supply of good water for the use of the inhabitants of this village.

There are still many villages in the State which, like Somerset, are greatly in need of a general supply of water, whose best interests would be materially advanced by the introduction of a public water supply, which in many cases the town or village can amply afford. The past dry seasons have imposed added hardship on many communities where a public water supply is not available, since numerous wells have become dry, necessitating the carrying of water from distant and sometimes objectionable sources.

It is very difficult, in most of the smaller towns, on account of the

opposition of those who live outside the villages, to secure action by the towns which will enable these thickly settled areas to be provided with proper water supplies, owing largely to the fear that the cost of a system of water works will be a serious financial burden, and to lack of knowledge of the fact that the introduction of a public water supply in even small villages has invariably proved a great public advantage without being a burden to the town.

The necessity to the health of a thickly settled community of an abundant supply of good drinking water is unquestioned, and it is important that such communities be given all the aid and encouragement possible in securing such supplies. It is also desirable that communities in which a public supply is badly needed should at least ascertain the cost of obtaining an adequate water supply before deciding against its introduction, since the cost of the necessary investigations cannot be considered a serious burden to the town. In the case of the town of Somerset no steps appear yet to have been taken to secure competent advice as to the practicability and probable cost of the introduction of a public water supply.

One other case is worthy of notice. The town of Medway was authorized, by an act of the Legislature passed in 1908, to supply itself and its inhabitants with water, and the town subsequently voted to accept the act and to introduce a public water supply; but, in order to raise the money necessary for the purpose, a vote of two to one was necessary, and although several meetings have since been held the number in favor of this great improvement in the sanitation of the town has not yet been found to be twice as great as the number of those who are opposed to it, and the construction of works has not yet been possible. In the mean time, great annoyance has been experienced during the past dry seasons owing to the drying up of wells in the villages of Medway and West Medway, and recent analyses of samples of water from a large number of wells still available for use and used most commonly by the people of those villages show that all of them are grossly polluted by sewage, and unfit for drinking.

In a few cases the wants of the smaller towns and villages are being met by the organization of water companies, and this method is of course a desirable one where the town will not make the necessary provision for an adequate public water supply.

The Deficiency in Rainfall and its Effect upon Public Water Supplies.

Since 1903, taking the State as a whole, there has been a deficiency of rainfall in every year. In 1907 the deficiency was very slight, and it was not very marked in the years 1904 and 1906. The deficiency in 1905 and again in 1908 was about 7½ inches.

The rainfall for the year 1909 has been considerably greater than in 1908, but was nevertheless below the normal. It has been unequally distributed, being fully up to the normal in the extreme eastern portions of the State, and much less than the normal in the western portions.

The effect of a year of low rainfall following so dry a season as that of the previous year has been to reduce the yield of watersheds and the flow of streams, and produce conditions very similar to those of 1908. The effect in 1909 has been more noticeable, however, to cities and towns which depend for their water supply upon lakes and reservoirs of considerable storage capacity; and, owing probably to the somewhat higher rainfall and its more even distribution through the year, has been less noticeable in the cases of towns dependent upon small streams with little storage, the flow of which has been comparatively well maintained throughout the year. The conditions have resulted in the exhaustion of several important public water supplies, and led to the introduction of temporary supplies in a number of places in which last year the quantity of water available was found to be sufficient.

The occurrence of two dry years succeeding a series of years of somewhat less than the average rainfall has produced a heavy draft upon the ponds and storage reservoirs used as sources of public water supply, and many of them have been drawn to a lower level than ever before. In consequence, wide areas of the shores and bottom of many of these sources have been exposed in some cases for several years, and these conditions have produced much complaint, especially in the cases of some of the natural ponds and lakes.

Notable among the natural ponds the level of which has been lowered excessively in recent years, and especially in the past year, are Farm Pond in the town of Sherborn, Crystal Lake in the town of Gardner, Sandy Pond in the town of Lincoln and Suntaug Lake in the town of Lynnfield.

In the case of Farm Pond in Sherborn, an act of the Legislature has already placed a limit to the future lowering of the water; and the investigations of the past year indicate that the Medfield Insane Hospital, which uses this pond as its source of water supply, can obtain

water for a part if not all of the purposes of the institution from the ground near the Charles River, and diminish materially the draft on the pond.

At Gardner the construction of works has already been begun for the purpose of introducing an additional supply of water into Crystal Lake, and preventing the further lowering of its level.

The excessive lowering of the water of Sandy Pond in Lincoln has not been necessary, since the Legislature granted the town of Concord the right to take water from Nagog Pond in Acton twenty-five years ago, but this grant was not utilized until the present year.

The excessive lowering of the water of Suntaug Lake in Lynnfield has caused much complaint from residents of the village near the lake, from various causes. The right to take water from this lake was granted to the town of Peabody as long ago as 1881, but permanent works for conveying water to the town were not completed until 1906. Since that time the level of the lake has been lowered many feet below the level of high water, and large areas of the bottom have been exposed. When the town of Peabody proposed to take water from Suntaug Lake in 1905 the plans were submitted to the State Board of Health for advice, as required by law; and the Board, after considering the scheme and calling attention to the small size of the watershed and the improbability that the lake, in connection with the other sources used by the town, would furnish sufficient water for its requirements for any long period of years, advised against the plan of taking water from this source, and urged the town to consider other sources. Subsequently the town again requested the advice of the Board as to the use of Suntaug Lake as a temporary source of water supply, and the Board advised that this lake appeared to be the best source available for the temporary use of the town, but again urged that other sources of water supply be investigated, and a supply of greater capacity provided as soon as practicable.

It does not appear that the town has yet taken any action towards making investigations for securing an adequate supply of water, as recommended in the communications referred to above. In the mean time, the consumption of water in the town — which in 1905 amounted to 1,750,000 gallons per day, and was at that time in excess of the safe capacity of the sources of supply, including Suntaug Lake, in a series of dry years — has increased greatly, the quantity of water used in the years 1907 and 1908 amounting, according to the records furnished by the town, to more than 2,300,000 gallons per day, or between 160 and 170 gallons per inhabitant. This rate of consumption is greatly in excess of the capacity of the present sources of supply, and

unless an additional supply of sufficient capacity shall soon be provided, the quantity of water in Suntaug Lake, as well as in Spring and Brown's ponds, must inevitably continue to decrease, excepting possibly in years of great rainfall, until the water in these lakes becomes exhausted.

Unsafe Public Water Supplies.

The consequences of the use of a sewage-polluted public water supply have often been revealed by sudden and widespread epidemics of typhoid fever or other water-carried disease, occurrences of which Massachusetts communities have given no important illustration for many years.

But the use of a sewage-polluted public water supply may have other injurious effects upon the public health than the spread of typhoid fever or other diseases known to be carried by water. Attention was first called to this fact in a report made to the Board by one of its members soon after the introduction of the Lawrence city filter in 1893, when there was a sudden and very marked decrease in the death rate of that city, the total number of deaths being less by five times the greatest previous number of deaths by typhoid fever. Studies as to the cause disclosed the fact that the reduction in the death rate was greatly in excess of that attributable to typhoid fever and other diseases known to be carried by water. Since that time similar results have been observed in other cities which have changed from a polluted to a pure or purified water supply. In these cities it has also been found that there has been a marked diminution in the death rate following immediately the introduction of a pure water supply or the purification of a polluted one, which is greatly in excess of the reduction attributable to the elimination of typhoid fever and other water-borne diseases.

The supervision of public water supplies provided for by an act of the Legislature of 1886, to ascertain their purity and fitness for domestic use or their liability "to impair the interests of the public or persons lawfully using the same, or imperil the public health," was designed for the purpose of protecting the public against the danger of polluted water supplies. Additional legislation has from time to time been enacted to secure further protection of the public health, and the interests of those who are dependent for their drinking water upon public supplies.

As indicated above, it has been many years since a serious epidemic traceable to a public water supply has occurred in Massachusetts, a result which is doubtless due in a very considerable degree to the enforcement of legislation adapted to their protection. It has given to the State a reputation for the protection of the public interests in this regard that has doubtless been of material advantage to it in other ways.

The limited supervision of public water supplies exercisable under

existing laws has usually been found sufficient for its purpose, and very few communities have been found to persist in supplying polluted water to the public after the danger has been pointed out. If the protection to the public health afforded by the statutes and by the care of its public water supply exercised by nearly every community in the State is to be efficient, the practice of supplying polluted water in any community after the fact is known should not be tolerated.

Water Supply of the City of Lynn.

The badly polluted condition of much of the water supply of the city of Lynn was first brought to the attention of the Legislature in January, 1906, and an act was then passed (chapter 509 of the acts of the year 1906) directing the State Board of Health and the water board of the city of Lynn to investigate plans for enlarging and improving the water supply of the city. The results of this investigation were presented to the Legislature in January, 1907. At this session an act was passed (chapter 479 of the Acts of the year 1907) authorizing the city of Lynn to enlarge and improve its water supply, and requiring that the construction of works be begun by the city, acting through its public water board, within one year and completed within three years after the date of the passage of the act (June 6, 1907). The act also provided for further investigation of various methods of enlarging and improving the water supply of the city. Nothing was done, however, toward constructing the works required by the act, but the city petitioned the Legislature of 1908 for an extension of time within which to begin the work, which was granted, and an act passed (chapter 610 of the Acts of the year 1908) entitled "An Act to extend the time within which the city of Lynn shall enlarge and improve its water supply," by the provisions of which the time for beginning the construction of works was extended to the first day of January in the year 1909, and the time of completion thereof to the first day of January in the year 1911. Again nothing was done by the city toward the construction of the works required by the act, and the matter again came up in the Legislature of 1909, when another act was passed still again extending for another year the time within which the construction of works for the enlargement and improvement of the water supply of the city of Lynn should be begun; *i.e.*, to the first day of January in the year 1910. The time for the completion of the works was extended to the first day of October in the year 1912.

Further delay on the part of the city of Lynn in providing a safe public water supply is wholly unnecessary, since it is thoroughly well known that the water supply of that city can be efficiently purified by

methods which have been in use in other cities for many years, at an expense which the city of Lynn is entirely able to incur without adding anything to the tax levy or increasing the water rates.

Other Water Supplies.

The conditions affecting the water supply of the towns of Abington and Rockland illustrate a danger to which a number of water supplies are rapidly becoming exposed. The water used by these towns has been taken for many years from Big Sandy Pond in Pembroke, the water of which in natural quality is among the best of surface waters. For many years after the works were introduced the watershed of this source contained but very few dwelling houses, and the pond and its main tributary, at the head of which is Little Sandy Pond, were visited occasionally by hunters and fishermen, but were exposed so little to pollution that danger of contamination could be guarded against by a very limited supervision.

In recent years cottages have been built in large numbers all about the shores of the ponds, and a large area of cranberry bogs has been constructed near the upper end of Big Sandy Pond and along its principal tributary. The water supplied through this tributary is derived largely from Little Sandy Pond, on the shores of which, in addition to numerous cottages, there is a large picnic ground with extensive provisions for boating and bathing, — a resort for great numbers of persons in summer.

The danger of the pollution of the water under these conditions has been brought to the attention of the authorities of the towns, but it is deemed impracticable now to purchase the land about the ponds and thus secure adequate protection of the purity of the water. There is little reason to doubt, however, that an adequate supply of ground water could be obtained in this region at a very reasonable cost, and the use of water from Big Sandy Pond discontinued; but, though the Board has called the attention of the town authorities to the danger involved in the continued use of Big Sandy Pond under present conditions, the town authorities decline to take action toward protecting the public health in this matter, and have not even sought to ascertain definitely the probable cost of obtaining a new and safe source of water supply.

Attention has previously been called to the unsafe condition of the water supply of Great Barrington, where no action has yet been taken toward providing safe drinking water, and there are other places where the conditions are not satisfactory. In most of the latter cases, however, the towns are making progress in the matter of securing adequate sanitary protection.

Rules and Regulations for the Sanitary Protection of Public Water Supplies.

Under authority of chapter 75, section 113, of the Revised Laws, authorizing the State Board of Health to make rules and regulations for the sanitary protection of public water supplies, the Board during the year 1909 established rules and regulations for the protection of the water supplies of Pittsfield (Onota Lake) and Winchester (north, south and middle reservoirs).

Examination of Sewer Outlets.

There are at the present time 116 cities and towns in the State which are provided with complete or partial systems of sewers. Of these, 26 cities and towns lying about the city of Boston are connected with the metropolitan sewerage systems, the sewage from which is disposed of by discharging it into the sea. The sewage of the main portion of the city of Boston is discharged at Moon Island, that of the north metropolitan system near Deer Island, and that of the south metropolitan system near Peddock's Island. These outlets have been examined as usual during the year, and no important change has taken place at either outlet since the conditions were reported to the Legislature of 1908. The sewage at Deer Island, which flows out at all stages of the tide, is rarely traceable at a distance of a mile from the outlet; while at Peddock's Island, where the discharge is also continuous, the sewage has very little effect upon the harbor water, and is noticeable only in the immediate neighborhood of the outlet. At Moon Island the conditions remain about the same as in past years.

In addition to the city of Boston and the cities and towns included in the metropolitan systems, there are 14 cities and towns which discharge their sewage either directly into the sea or into tidal estuaries connected therewith. The main sewer outlet of the city of Salem and town of Peabody discharging into Salem harbor has been the subject of careful observation during the year, and observations have also been made upon the effect of the disposal of sewage from the Beverly sewers, the outlet of which discharges into Beverly harbor. Much of the sewage and manufacturing waste which was formerly discharged into the North River is now disposed of by means of the sewers of Salem and Peabody, but the condition of that stream remained objectionable during much of the year. Measures have recently been taken by the authorities of the city of Salem to prevent the further pollution of the stream by manufacturing waste.

There has been a considerable growth of the tanning industry in the

adjacent town of Danvers, and tannery refuse discharged into tidal estuaries in that town is creating a considerable nuisance.

Of the main sewers discharging into the sea, the most objectionable, as noted in previous reports, are the outlets of the cities of Lynn and New Bedford. The sewage of the city of Lynn is discharged at all stages of the tide into a small branch of the harbor channel, where there is no strong current to remove the sewage. In consequence, in calm weather, or when the wind is east or south, the sewage remains near the outlet or is carried toward the shore, and solid matters from the sewage are deposited on the bottom of the harbor and along the shores in the neighborhood. There are wide areas of flats exposed at low water in this region which are now covered with a deep deposit of sewage sludge, and the conditions all about this outlet are very offensive during much of the year. This matter was brought to the attention of the Legislature last year, and it was stated by representatives of the city of Lynn that investigations were then to be made with a view to a proper disposal of the sewage. It is understood that these plans have been completed, but no action appears to have been taken as yet by the city.

At New Bedford the sewage of about two-thirds of the city is discharged at numerous outlets along the shores of the harbor and in the Acushnet River, while the sewage of the remaining third is discharged at the head of Clark's Cove. Nuisances are created at several points, the most serious of which is found in Clark's Cove, where there is no strong current for the removal of the sewage, and the prevailing winds in summer cause it to collect near the upper end of the cove, where it creates a very offensive nuisance in a thickly populated neighborhood. A plan for relieving the nuisance was submitted to the Board for its consideration during the year, but the plan was not satisfactory, and the city is now making an investigation of plans for the collection of the sewage from the present outlets and disposing of it by discharging it into the sea at a main outlet off Clark's Point south of the city.

The remaining sewer outlets have been considered in connection with the examination of rivers.

Pollution of Rivers.

The effect of the pollution of the rivers of the State by sewage and foul drainage from manufacturing establishments has increased greatly in the past few years, and during the past year numerous complaints have been made of serious nuisances caused by the pollution of various rivers.

The first action by the Legislature dealing with the general subject of stream pollution appears to have been taken in 1872, when an order was

adopted directing the State Board of Health to collect information concerning the disposal of sewage, the pollution of streams and of the water supplies of towns, and make a report at its next session; and, in compliance with this direction, the Board, after investigation, made a report on the subject to the Legislature of 1873.

The condition of the various rivers was subsequently reported in detail from time to time. Finally, the whole question of dealing with the prevention of the pollution of streams in Massachusetts was submitted to a commission known as the Massachusetts Drainage Commission, appointed in 1884 to consider especially a general system of drainage for the relief of the Mystic, Blackstone and Charles rivers, and, further, to consider and report upon the needs of other portions of the Commonwealth regarding water supply and sewerage. The recommendations of this commission, so far as they relate to the prevention of the pollution of streams, were in part as follows: —

We think it would be well, then, for the Legislature to designate some one or more persons to look after the public interests in this direction. Let these guardians of inland waters be charged to acquaint themselves with the actual condition of all waters within the State as respects their pollution or purity, and to inform themselves particularly as to the relation which that condition bears to the health and well-being of any part of the people of the Commonwealth. Let them do away, as far as possible, with all remediable pollution, and use every means in their power to prevent further vitiation. Let them make it their business to advise and assist cities or towns desiring a supply of water or a system of sewerage. They shall put themselves at the disposal of manufactories and others using rivers, streams or ponds, or in any way misusing them, to suggest the best means of minimizing the amount of dirt in their effluent, and to experiment upon methods of reducing or avoiding pollution. They shall warn the persistent violator of all reasonable regulation in the management of water of the consequences of his acts. In a word, it shall be their especial function to guard the public interest and the public health in its relation with water, whether pure or defiled, with the ultimate hope, which must never be abandoned, that sooner or later ways may be found to redeem and preserve all the waters of the State. We propose to clothe the Board with no other power than the power to examine, advise and report, except in cases of violation of the statutes. Such cases, if persisted in after notice, are to be referred to the Attorney-General for action. Other than this, its decisions must look for their sanction to their own intrinsic sense and soundness. Its last protest against wilful and obstinate defilement will be to the General Court. To that tribunal it shall report all the facts, leaving to its supreme discretion the final disposition of such offenders.

The recommendations contained in the report of this commission were enacted into law, and under those laws the powers of the Board in dealing

with the pollution of rivers, except in the specific instance of the Neponset River and limited areas in certain other watersheds, are simply advisory. By the revision of the statutes in 1902, the portion of this authority which relates to the Merrimack and Connecticut rivers, and a portion of the Concord River, was removed. The laws requiring the submission of plans of proposed drainage and sewerage systems to the State Board of Health for its advice before their construction have operated to prevent further objectionable pollution of most of the rivers, since in most cases cities and towns have complied with the advice of the Board in these matters; but the Board has no power to prevent or limit the pollution of rivers by those cities and towns in which sewerage systems had already been constructed before the laws requiring the advice of the Board were enacted. There is still a large number of such cities and towns, and, while in some instances municipalities which have used the rivers as places of sewage disposal for many years have by the advice of the Board discontinued this practice, the Board has no further power of action in cases where a city or town persists in continuing the objectionable pollution of the river, except to report the facts to the Legislature.

North Branch of the Nashua River.

The condition of this river has been objectionable for many years. Plans for purifying the sewage and manufacturing waste of the city of Fitchburg before discharging them into the river were considered many years ago, and in the year 1901 the city secured legislation (chapter 354 of the Acts of the year 1901) to enable it to construct a system of sewage disposal.

A very thorough investigation of the whole question was made by expert sanitary engineers, and plans for a system of sewage disposal were presented to the Board for its approval, under the provisions of the above act, on Dec. 2, 1903, and were approved on Dec. 17, 1903. When these plans were presented to the Board it was proposed to construct in the beginning a trunk sewer and disposal works for the collection and purification of the dry-weather flow of sewage, and subsequently to effect gradually the separation of the sewage from the storm water. In view of the conditions, it was desired to extend the latter work over as long a period as practicable; and, considering all the circumstances, the date for the final completion of this work was placed at Jan. 1, 1915.

Nothing having been done by the city toward beginning the construction of any portion of these works, the Board brought the matter to the attention of the Legislature in January, 1908, for such action as the Legislature might deem necessary, since the pollution of the river

had created a nuisance. The committee of the Legislature of 1908 to which the report was referred gave several hearings upon the matter, and subsequently, upon the assurance of the mayor that he would bring the matter to the attention of the city council for action, no legislation was deemed necessary. The matter was referred to the city council in the latter part of that year, but no action was taken, and the Board again reported the facts to the Legislature of 1909. After several hearings, the committee on drainage, to which this matter was referred, made a report to the Legislature relative to the pollution of the north branch of the Nashua River by the discharge of the sewage of the city of Fitchburg into that stream, which is printed in the journals of the Senate and House. The committee reported as follows: —

that they have carefully considered the matter, and are firmly convinced that there is just cause for complaint because of conditions existing at that point. They do not, however, believe that it is wise to alter existing legislation now governing the actions of said city in connection therewith. They believe that the city of Fitchburg is sincere in its assurances that it intends to remedy this evil at the earliest opportunity, but in their opinion the time has arrived when the parties should show by definite actions to the State Board of Health that their intentions are sincere. And the committee further believe that said city should show to the State Board of Health from time to time that some definite progress has been made in the separation and disposal of its sewage. —Journal of the Senate, June 7, 1909, page 1085.

The Board reports that no definite progress has been made by the city of Fitchburg during the year 1909 either in the separation or disposal of its sewage. In the mean time, the condition of the river has become much worse than ever before, and its pollution has been a source of complaint for a distance of more than thirty miles below the city.

Time will be required to construct a system of sewage disposal and provide trunk sewers necessary for diverting the sewage from the river; and if this work were prosecuted with the utmost diligence, it could hardly be advanced to such a point as to relieve materially the pollution of the river in less than two years. In the opinion of the Board, it is important that further unnecessary delay in the removal of pollution from the north branch of the Nashua River shall be prevented.

Pollution of the Assabet River.

The Assabet River has again been very offensive below the sewage disposal works of the town of Westborough during much of the drier portion of the year. Its condition has also been very objectionable below Hudson and again below Maynard. The pollution of the stream below

the Westborough filter beds is caused by the imperfectly purified effluent discharged into the river from those works. The inefficient operation of the filters is due largely to the discharge into the sewers of the wastes from a yeast factory, which contain yeast and alcohol in such quantities as to clog the filters and arrest nitrification. Plans for enlarging the filter beds were approved by the Board during the past year, and the additional filters have been partially constructed.

Acting under the provisions of chapter 433 of the Acts of the year 1909, the Board, on Nov. 4, 1909, issued an order to the proprietors of the yeast factory requiring treatment of their waste before its discharge into the sewers in such a manner as to prevent interference with the operation of the purification works.

The pollution of the stream below Hudson is due largely to the same cause as at Westborough, — the unsatisfactory operation of the works for the purification of the sewage. In this case the failure of the filter beds to purify the sewage satisfactorily is due to the discharge into the sewers of the wastes from a woolen mill containing an excessive quantity of fats, which has clogged the filters and prevented nitrification. The construction of additional filter beds at this place also was begun during the past year.

Early in July the owner of a factory on the stream below Hudson brought action in the Supreme Court to prevent the pollution of the river, and, under the direction of the court, works have been constructed for the treatment of the waste from the woolen mill before its discharge into the sewers.

At both Westborough and Hudson it is probable that the new filter beds will have to be completed before it will be practicable to restore the old ones to their former condition, and secure again the efficient purification of the sewage of these towns.

At Maynard the pollution of the stream is caused chiefly by the wastes from a large woolen mill, though the stream is also polluted by a small amount of sewage from the town. The proprietors of the woolen mill and the authorities of the town have been advised to purify the waste and sewage, to prevent the further pollution of the river.

Pollution of the Hoosick River.

The condition of the Hoosick River in North Adams and Williamstown has become increasingly objectionable in the last few years, and has now reached the stage where it is a nuisance and likely to be injurious to the health of the dense population living in its valley. The Board has notified the towns of Adams and Williamstown and the city of North Adams of the condition of the river, and has advised the puri-

fication of the sewage of those places before its discharge into the stream.

The town of Adams during the past year prepared a plan for the collection and disposal of its sewage, which was subsequently submitted to and approved by the Board, and it is understood that investigations relating to the treatment of the sewage have been begun in the city of North Adams.

The condition of this stream is rapidly becoming more objectionable, and it is important that there shall be no delay in relieving the pollution of this river.

Pollution of the Neponset River.

Under the provisions of chapter 360 of the Acts of the year 1906 many of the sources of pollution of this stream have been removed, and with the completion of the sewage purification works of the town of Norwood, and the diversion of the sewage from the sewer of that town to the filter beds, the pollution of the river by domestic sewage has ceased.

Many of the factories have begun the construction of works for the purification of their wastes, but large quantities of foul refuse still find their way into the stream, and the condition of the river during the last half of the year has been very objectionable. The character and amount of the wastes discharged into the stream have been determined, and practicable methods for their purification have been selected. Under advice of the law department of the Commonwealth, proceedings are being taken against those who are not complying with the law.

Pollution of the Housatonic River.

The city of Pittsfield and the towns of Lenox and Stockbridge in the valley of this stream are provided with sewage disposal works, and in the case of the town of Stockbridge all of the sewage is purified before being discharged into the stream. At Pittsfield the purification works have been efficiently operated, and all of the sewage brought to the works has been well purified before being discharged into the river. The works have not yet been extended sufficiently, however, to collect all of the sewage and manufacturing waste which pollute the streams in the city, and considerable sewage still reaches the river and its tributaries which should be removed and diverted to the sewage purification works.

At Lenox, attention having been called to the pollution of the river by the sewage of that town and the need of additional purification works, the town has taken up the matter during the past year, and caused investigations to be made and plans to be prepared, which, if carried out, will provide adequately for the purification of the sewage.

While the city of Pittsfield and the towns of Lenox and Stockbridge

have constructed and are now maintaining works for the purification of their sewage to prevent the pollution of the river, the towns of Dalton, Lee and Great Barrington discharge all of their sewage directly into this river without previous treatment. This inequality of responsibility for maintaining proper sanitary conditions in this valley has come about through the fact that sewers existed in these towns before the passage of laws relating to the pollution of streams, and the systems can be indefinitely extended without making them amenable to existing laws relating to the pollution of streams. It is desirable that the expense and responsibility of maintaining a clean river should fall upon all of the towns instead of being borne by a part of them.

Pollution of the Merrimack River.

The condition of the Merrimack River was very thoroughly investigated in the year 1908, as required by chapter 114 of the Resolves of that year, and the results were reported in detail to the Legislature of 1909. An act was subsequently passed (chapter 505 of the Acts of the year 1909) requiring the Board to examine the river and its tributaries at such times as it may deem proper, and whenever it shall determine that its condition is likely to become injurious or dangerous to the public health to prepare a plan for removing the cause of such injury or danger and report the same to the General Court.

Examinations made during the past year show that the river is badly polluted and contains much objectionable matter, and refuse, from manufacturing waste, which is most noticeable below the city of Lawrence.

Pollution of the Taunton River.

During the year serious complaint was made of the condition of the Matfield River, one of the tributaries of the Taunton, flowing through Brockton and East Bridgewater, and investigation has shown that the stream is being badly polluted by wastes from manufacturing and industrial establishments, chiefly in the city of Brockton. The owners of these establishments have been notified of the necessity for treating their wastes in such a manner as to prevent the pollution of the river.

The Nemasket River, one of the main branches of this stream, is badly polluted by the sewage of the town of Middleborough, and the main stream is polluted by the sewage of the city of Taunton which is discharged into the river below the city under plans approved by the State Board of Health several years ago, which require the removal of the sewage from the river on or before July 1, 1910, and its purification upon a certain area of land in Berkley acquired by the city and set apart for this purpose several years ago.

Objectionable Conditions in Other Streams.

Green River, one of the principal tributaries of the Deerfield River, is badly polluted near its mouth by the sewage of the town of Greenfield, which has caused a very serious nuisance in this stream for several years. Plans are now being prepared for removing the sewage from the river and providing a proper method of sewage disposal for the town.

The Ware River is badly polluted at several points by sewage and manufacturing wastes. At Barre, on the upper waters of the river, the discharge of wastes from a wool-combing plant has created a serious nuisance. The river receives further pollution at Wheelwright and Gilbertville, and at Ware is polluted by large quantities of wool-scouring waste and by the sewage of the town. Below Ware the effect of the pollution is becoming very objectionable.

The French River is polluted at various points along its course, chiefly by woolen mill wastes, and at Webster it receives an enormous quantity of waste from a woolen mill and in addition the entire sewage of the town. Its condition below the town during the past year has been very objectionable.

The Spicket River, a tributary of the Merrimack which flows through the town of Methuen and a densely populated portion of the city of Lawrence, has in previous years been a source of complaint, but during the past year has been a very objectionable nuisance. The river is polluted considerably by manufacturing wastes in the town of Methuen, but an investigation has shown that the chief cause of the trouble during the present year was the manufacturing waste discharged from certain processes in the Arlington mills, though the stream is also considerably polluted by sewage. The banks of the stream, which are overgrown in places by bushes, were in an objectionable condition, and there were considerable deposits of offensive matter on the sides and bottom of the stream. The Board has recommended a plan for improving the condition of this river, which, if carried out, will prevent further nuisance therefrom.

The condition of the Blackstone River, which has long been the worst-polluted stream in the State, has begun apparently to show improvement.

The Ten Mile River, which has become a serious nuisance by reason of the sewage of Attleborough and North Attleborough, which is discharged untreated into the stream, is in process of improvement, the construction of sewerage works having already been begun in North Attleborough, while plans for the works which are to be constructed during the coming year are being prepared by the town of Attleborough.

Charles River Basin.

The plan of converting the tidal estuary of Charles River into a fresh-water basin, proposed by a joint board consisting of the Metropolitan Park Commission and the State Board of Health in a report presented to the Legislature in 1894 and adopted by chapter 465 of the Acts of the year 1903, has been practically completed, and in October, 1908, the flow of the tides was shut off at a dam at Craigie bridge between Boston and Cambridge. With the high flows of fresh water in the river during the winter and spring of 1909 salt water was gradually excluded, and the river has been maintained during the past year as a fresh-water basin. The result predicted has been realized. This unsightly and at times offensive estuary has been converted into an attractive fresh-water lake, and a great improvement in the drainage of its shores and of neighboring areas has been made possible. The level of the water, which formerly rose at times of high tide to 10.5 feet above low water in Boston harbor, and frequently to 12 feet or more above that level, flooding the basements of many of the houses on the water side of Beacon Street, is now maintained at all times at a level of approximately 8 feet above low water.

The dam has already proved of incalculable value in protecting the comfort and health as well as the property of the inhabitants in the densely populated low lands in the Back Bay district, and elsewhere along the valley of the Charles River estuary, by preventing the entrance of the tide in the great storm of Dec. 26, 1909, when the tide rose to grade 15.68 above low water[1] in Boston harbor, — a level slightly higher (0.02 of a foot) than the Minot's Ledge tide of April, 1851, and .78 of a foot higher than in the great "Portland" storm of Nov. 26, 1898.

At the lower side of the dam the maximum height of the water was 15.79. The grade of the streets in the Back Bay district is in many places below 17, and the level of Back Street, which borders the river in the rear of Beacon Street, is below grade 14. Cellars in this region are at grade 12, and the yards in some places in the districts tributary to the new basin in this region are as low as grade 10.

Had this enormous tide entered the river freely, as before the dam was built, it must have caused great discomfort and injury to the inhabitants, and damages of many thousands of dollars to property throughout a wide area of lowland bordering the river above the dam.

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[1] Boston city base.

The condition of the water of the basin has remained satisfactory throughout the year. It still receives a considerable amount of unnecessary pollution, which is being gradually diminished.

Lawrence Experiment Station.

During 1909 fifty-one filters have been in operation at the Lawrence Experiment Station. Twelve of these have been used for studies on the purification of water, twenty on the purification of domestic sewage, and nineteen on the purification of manufactural wastes. The sand filters to which the sewage has been applied for a period of nearly twenty-two years have been continued in operation, and have produced effluents as well or better purified than during many of the preceding years.

Contact filters which have been used for eight years, and sprinkling filters in use for ten years, are still in operation. Long-continued studies of these different classes of filters have yielded very valuable information as to the volume of sewage which can be treated upon the filters of each type without impairing their efficiency, and have furnished much valuable experience in regard to methods of operation necessary to maintain such filters in satisfactory and permanent operation.

Most important and valuable at the present time is the work done at the experiment station in the investigation of methods for the purification of waste from manufacturing establishments which are the sources of much of the pollution of the rivers in this State. These wastes are of such a character that they are often very difficult to purify, but they must be treated by methods which are practicable and reasonably available. These wastes are in great variety, and include liquors from the processes of manufacturing paper, leather, cotton and woolen goods, yeast, fish glue, gas, etc. Besides this, various methods have been studied for the disposal of sludge resulting from the sedimentation of sewage and of the effluents of trickling and contact filters by means of settling tanks and in other ways. In this connection new types of settling tanks have been studied, and the operation of filters constructed of horizontal layers of slate, begun in 1901, has been resumed. The investigation of the disposal of sewage sludge by destructive distillation, begun in 1908, has been continued, and much information obtained as to the value of the gases, coke and other products resulting from this process.

The studies on water filtration have included the operation of numerous slow sand and mechanical filters and of double filtration systems. Particular attention has been devoted to the effect of the rate of filtration on the efficiency of slow sand filters, and a series of filters constructed of the same depth of sand and receiving water of the same char-

acter have been operated at rates varying from two and one-half million to twenty million gallons per acre daily. Studies have also been made on the removal of color from highly colored water by the use of different coagulants followed by filtration. Filters of broken stone operated with water, in the same manner as trickling filters are operated with sewage, have been studied, and the results obtained have helped to make clear some of the causes hitherto not thoroughly understood as to the purification of water by biological action. An investigation of the use of various disinfectants in connection with the purification of water and sewage has also been in progress, and much information as to the efficiency of disinfectants of various kinds when used for the purpose has been obtained.

As during previous years, all the bacterial work for the department of water supply and sewerage has been carried on at the station.

Supervision of the Business of Plumbing.

Acts of 1909, Chapter 536.

An Act relative to the Supervision of the Business of Plumbing.

Section 1. Within thirty days after the passage of this act, the state board of health shall appoint three examiners of plumbers. The first shall be a practical plumber of at least five years' continuous practical experience. The second shall be a sanitary expert, and the third shall have such qualifications as may be required by the state board of health. . . . The compensation of the state examiners of plumbers, together with the travelling and other necessary expenses of the clerk shall, when approved by the chairman of the state board of health and by the governor and council, be paid from the treasury of the commonwealth.

Section 2. The state examiners of plumbers may make such rules as they deem necessary for the proper performance of their duties, which rules shall take effect when approved by the state board of health. . . .

Section 3. . . . The report of the state examiners of plumbers shall be a part of the annual report of the state board of health.

Section 5. Upon petition of the board of health of any town which has not accepted the provisions of chapter one hundred and three of the Revised Laws, the said examiners shall formulate rules relative to the construction, alteration, repair and inspection of all plumbing work within such town, which rules, when approved by the state board of health and accepted by the board of health of such town . . . shall thereafter have the force and effect of law. . . . The decision of said examiners shall be subject to the approval of the chairman of the state board of health, and a copy of the decision shall be served on each of the persons interested. . . .

At a special meeting of the Board, held on July 15, 1909, it was voted to make the following appointments: —

First examiner (clerk), Edward C. Kelly of Boston.
Second examiner, James C. Coffey of Worcester.
Third examiner, Charles R. Felton, C.E., of Brockton.

The detailed report of the State Board of Examiners of Plumbers will be found in the Supplement.

Dealers in Cigarettes to post Certain Notices.

As directed by section 3 of chapter 346 of the Acts of 1909, the following notice was printed by the Board and sent on request to the police authorities of cities and towns: —

To the Proper Authorities of Cities and Towns in the Commonwealth:

Your attention is respectfully called to the following law, recently enacted: —

Chapter 346 of the Acts of 1909.

An Act to require Dealers in Cigarettes to post Certain Notices.

Be it enacted by the Senate and House of Representatives in General Court assembled and by the authority of the same, as follows:

Section 1. Section three of chapter two hundred and thirteen of the Revised Laws is hereby amended by adding at the end thereof the following: — A copy of this section printed in letters not less in size than 18 point capitals, bold face, shall be posted conspicuously in the shop or other place of sale used by any person selling cigarettes at retail, and whoever violates this provision shall be punished as above described, — so as to read as follows: — *Section 3.* Whoever sells a cigarette to a person under eighteen years of age, or whoever sells snuff or tobacco in any of its forms to a person under sixteen years of age, or, not being his parent or guardian, gives a cigarette to a person under eighteen years of age, or gives snuff or tobacco in any of its forms to a person under sixteen years of age, shall be punished by a fine of not more than fifty dollars. A copy of this section printed in letters not less in size than 18 point capitals, bold face, shall be posted conspicuously in the shop or other place of sale used by any person selling cigarettes at retail, and whoever violates this provision shall be punished as above prescribed.

Section 2. It shall be the duty of the police department of cities and towns where such exist, and of constables in towns not having a police department, to see that a copy of the said section three, as above amended, is posted in a conspicuous place where it can easily be read, in every shop or place where cigarettes are sold at retail. Any person unlawfully removing the said copy while cigarettes are still sold on the premises where it is posted shall be subject to a penalty of ten dollars.

Section 3. Copies of the said section, printed as above specified, shall be prepared by the state board of health, and shall be delivered without charge to the cities and towns applying for them.

Section 4. This act shall take effect sixty days after its passage. [*Approved May 3, 1909.*

Changes in Legislation which affect the Work of the State Inspectors of Health.

Statute Provisions at the End of the Legislative Session of 1908.

1. In accordance with chapter 106, sections 47, 48 and 50, Revised Laws, State Inspectors of Health issued orders relative to providing proper water-closets for both sexes in factories, workshops, mercantile or other establishments or offices in which two or more children under eighteen years of age or women are employed.

2. State Inspectors of Health enforced the provisions of chapter 106, sections 54 and 55, Revised Laws, relative to sanitary and ventilating provisions in schoolhouses and public buildings.

Statute Provisions at the End of the Legislative Session of 1909.

1. In codifying the laws relating to labor, sections 47, 48 and 50 of chapter 106, Revised Laws, above referred to, were so changed that the words "the inspection department of the district police" were substituted for the words "a state inspector of health," so that State Inspectors of Health no longer have authority to issue orders relative to water-closets in factories, workshops, mercantile or other establishments or offices in which two or more children under eighteen years of age or women are employed.

2. In codifying the laws relating to labor the words "inspector of factories and public buildings" were substituted for the words "a state inspector of health" in the provision of the law relating to the sanitation and ventilation of public buildings and schoolhouses, above mentioned, so that State Inspectors of Health no longer have authority to issue orders providing for "further or different sanitary or ventilating provisions in public buildings or schoolhouses."

In order that information relative to the sanitation of schoolhouses might be given from time to time to the Legislature, a new act was passed, which provided that the State Inspectors of Health should retain their power to examine such buildings. This new act provides that "the state inspectors of health or such other officers as the state board of health may from time to time appoint shall make such examinations of school buildings as in the opinion of said board the protection of the health of the pupils may require."

Changes in Legislation which affect the Duties of Local Health Authorities.

During the year 1908, if any person was aggrieved by the order of a State Inspector of Health relative to changes in sanitation and ventilation of school buildings the local board of health, after notice to all the parties interested, gave a hearing upon such order, and altered, annulled or affirmed it; in June, 1909, when the act codifying the laws relating to labor was passed, in which it was provided that all orders for further or different sanitary provisions in schoolhouses should be issued by the District Police, provision was made that whoever was aggrieved by an order so issued could not appeal to the local health authority but might appeal to the judge of a superior court.

Desirability of Changing the Limits of Certain Health Districts.

Section 1 of chapter 537 of the Acts of 1907 provides that: —

> The state board of health shall, as soon as may be after the passage of this act, divide the commonwealth into not more than fifteen districts, to be known as health districts, in such manner as it may deem necessary or proper for carrying out the purposes of this act.

In accordance with this act the Board divided the State into certain definite districts. Experience has shown, however, that in the interest of increased efficiency the limits of these districts should now be somewhat modified. The Board, therefore, recommends that legislation be enacted giving the Board power to change, from time to time, with the consent of the Governor and Council, the limits of these districts.

Section 6 of chapter 537 of the Acts of 1907 provides that: —

> The governor, with the advice and consent of the council, shall establish the salaries of said state inspectors of health, having regard in each district to the extent of territory, the number of inhabitants, the character of the business there carried on, and the amount of time likely to be required for the proper discharge of the duties. The salaries thus established shall be paid from the treasury of the commonwealth monthly.

Likewise, in the interest of increased efficiency, the Board recommends that legislation be enacted to provide that whenever it becomes necessary to appoint or to re-appoint a State Inspector of Health the Board be given power to establish the salary of said State Inspector of Health, with the consent of the Governor and Council, having regard, in each district, to the extent of territory, the number of inhabitants, the character of the

business there carried on and the amount of time likely to be required for the proper discharge of the duties.

Furthermore, the Board recommends that legislation be enacted to provide that "after the division aforesaid has been made, the board, when ever it becomes necessary to appoint or to re-appoint a state inspector of health, shall, with the consent of the governor and council, appoint in each health district one practical and discreet person, learned in the science of medicine and hygiene, to be state inspector of health in that district. Every nomination for such office shall be made at least seven days prior to the appointment. A state inspector of health thus appointed shall hold his office for a period of five years from the time of his appointment, but shall be liable to removal from office by the state board of health, with the consent of the governor and council, at any time."

The Common Drinking Cup.

Inasmuch as there can be no doubt that the use of the common drinking cup is a menace to the public health, in that it favors the spread of diseases, such as tuberculosis, syphilis, diphtheria, scarlet fever, measles and grippe, the Board recommends that appropriate legislation be enacted for the abolition of the use of the common drinking cup in public buildings, parks, public and private schools, railroad stations, railroad trains, ferryboats, steamboats, factories, mills, workshops, theatres, public halls and public libraries.

Amendment of Law relative to the Sale of Cocaine.

Acts of 1909, Chapter 375.

An Act relative to the Sale of Cocaine.

Be it enacted, etc., as follows:

Section 1. Section two of chapter three hundred and seven of the acts of the year nineteen hundred and eight is hereby amended by inserting after the word "restaurant", in the fifth and sixth lines, the words: — apartment house, dwelling house, — so as to read as follows: — *Section 2.* It shall be unlawful for any person, firm or corporation to sell, exchange, deliver, expose for sale, give away or have in his possession or custody with intent to sell, exchange, deliver or give away, in any street, way, square, park or other public place, or in any hotel, restaurant, apartment house, dwelling house, liquor saloon, barroom, public hall, place of amusement, or public building any cocaine or any of its salts, or any alpha or beta eucaine, or any of their salts, or any synthetic substitute for the aforesaid, or any preparation containing any of the same.

Section 2. Section four of chapter three hundred and eighty-six of the acts of the year nineteen hundred and six is hereby amended by adding at the end thereof the words: — and shall at all times be open to inspection

by the officers of the state board of health and by the police authorities and officers of cities and towns, — so as to read as follows: — *Section 4.* It shall be unlawful for any person to sell, or to expose or offer for sale, or to give or exchange any cocaine or alpha or beta eucaine or any synthetic substitute of the aforesaid, or any preparation containing the same, or any salts or compounds thereof, except upon the written prescription of a physician, dentist or veterinary surgeon registered under the laws of the commonwealth; the original of which prescription shall be retained by the druggist filling the same and shall not again be filled, and shall at all times be open to inspection by the officers of the state board of health and by the police authorities and officers of cities and towns. [*Approved May 11, 1909.*

In spite of many efforts so to frame legislation that the harmful use of cocaine, its salts and derivatives, by those addicted to their use, might be effectually restricted, the work of those engaged in combating this evil is carried on with great difficulty.

Although it is well known that certain firms and individuals deal illegally in this drug, evidence of such dealing sufficiently strong to stand in a court of law is very hard to obtain.

The Board, therefore, strongly recommends further legislation looking to a strengthening of the law relative to the sale of cocaine, its salts and derivatives.

Food and Drug Inspection.

The number of samples of food and drugs collected and examined during the year ended Nov. 30, 1909, was 7,337, and the total number since the work was begun in 1882 has now reached 190,620.

During the year 296 prosecutions were made in the various courts of the Commonwealth, bringing the total up to 3,572. The details are presented in the Supplement.

Inspection of Liquors.

The work of the Board in connection with the duties of the office of inspector and assayer of liquors, transferred to the Board in 1902, is reported upon in the Supplement.

Diseases Dangerous to the Public Health.

At a meeting of the State Board of Health, held on May 6, 1909, it was voted that *ophthalmia neonatorum* and *trachoma* be declared diseases dangerous to the public health, and therefore notifiable under sections 49 and 50 of chapter 75 of the Revised Laws.

Furthermore, on Nov. 4, 1909, a similar vote was passed concerning *anterior poliomyelitis.*

Outbreaks of Infectious Disease.

Anterior Poliomyelitis.

The Board has continued in 1909 its investigation of anterior poliomyelitis (infantile paralysis). The incidence of this disease has been very extensive, reaching the very unusual number of nearly 1,000 cases, grouped for the most part in the neighborhood of the city of Boston.

The disease is one of the greatest importance, being characterized not only by a very considerable death-rate, but also by varying degrees of paralysis in those who recover. As a factor, therefore, in the health of the inhabitants of the Commonwealth, anterior poliomyelitis is a disease worthy of the very extended investigation which is being made by the Board. Our knowledge concerning the infection has been very remarkably increased during the past year, and it is hoped that in the near future the cause of this dangerous disease may be discovered and the manner of its spread made clear.

In order, however, that the investigation may be carried on in the most thorough manner, the Board should be able to call to its assistance a number of physicians especially conversant with the work, and to this end the Board earnestly recommends an addition to the appropriation for the general purposes of the Board to the extent of at least $5,000.

Typhoid Fever.

The most extensive epidemic of typhoid fever was that occurring as a result of the contamination of milk at the Mount Pleasant Hotel in Jefferson. This epidemic affected 58 individuals from different parts of the State, and was due to the contamination of the milk supply by a waitress in the early stages of the disease. The details of this epidemic, and also a similar one in the town of Maynard, due to a chronic bacillus carrier, will be found in the Supplement.

A detailed report by Dr. Donald Gregg, special investigator of the Board, upon the origin and prevalence of typhoid fever in Boston in 1909, will also be found in the Supplement.

Inspection of Dairies.

During the year ended Nov. 30, 1909, 1,771 dairies were examined by the veterinarian of the Board, and the attention of the boards of health of the cities and towns wherein the dairies were situated or the product thereof sold was called to a total of 3,375 objectionable conditions. As in former years, suggestions were made as to changes regarded as necessary in the interest of a wholesome supply and of the public health.

Of the total number of dairies examined, 1,439 were situated in Massachusetts and 332 in neighboring States. The extra-state dairies were visited because of the fact that their product is marketed in this Commonwealth, and, if found to be other than the fresh, clean product of healthy cows, is, under the standards fixed in accordance with the provisions of the national law relative to food and drugs, to be deemed to be adulterated, and hence may not enter into interstate commerce. The details will be found in the Supplement.

Authority of Inspectors of the Board to take Samples of Milk.

Section 5 of chapter 263 of the Acts of 1882 reads: "The state board of health . . . shall take cognizance of the interests of the public health relating to the sale of drugs and food and the adulteration of the same . . . and . . . may appoint inspectors. . . ."

Section 4 of chapter 352 of the Acts of 1885: ". . . said inspectors [that is, of cities and towns] . . . may enter all places where milk is stored or kept for sale and all carriages used for the conveyance of milk, and said inspectors or their assistants may take samples for analysis from all such places or carriages."

Section 5 of the same chapter provides that "inspectors appointed under the provisions of chapter two hundred and sixty-three of the acts of the year eighteen hundred and eighty-two" (that is, inspectors of the State Board of Health) "shall have the power and authority conferred upon a city or town inspector by the preceding section."

In the revision of the milk laws in 1902, this statute, empowering inspectors of the State Board of Health to take samples of milk, was omitted, and it might well occur that an inspector of the State Board of Health might be unable to show any authority for taking samples of milk or for prosecution of any person obstructing him in an effort to take such samples of milk. It would, therefore, seem advisable that legislation be asked safeguarding the authority of the milk inspectors to take specimens of milk wherever it seems advisable.

Proprietary Medicines.

During the year 17 proprietary preparations containing alcohol, and with no statement or with incorrect statement as to the amount, were advertised as unsalable at retail, under the provisions of chapter 386 of the Acts of 1906, namely: —

White Pine Expectorant with Tar.
Professor Penney's Body Regulator.
Elixir of Riga. (Russian liquor.)

Dr. Wilson's Wine of Cod Liver Oil, with Malt, Wild Cherry and Hypophosphites.

Rocko-Ryo: Rock and Rye Compound.

Horehound, Rock and Rye.

Chionia.[1]

Stearns's Wine[1] (Vinum Olei Morrhuae, Stearns): Stearns's Wine of Cod Liver Oil with Peptonate of Iron.

Royal Brand Cordial.

Shaw's Malt.[1]

Joyce's Brand Superior Malt.

Larkin Root Beer Extract.

Hires.[1] (A root beer extract.)

Dr. Swett's Root Beer Extract.[1]

Indian Root Beer Extract.

Bryant's Root Beer.[1] (A root beer extract.)

A. & P. Root Beer.

The following proprietary preparation containing acetanilid, with no statement as to its presence or amount, was also advertised as unsalable at retail: —

Bok's Cold Tablets.

Maple Sugar, Maple Syrup, etc.

Paragraph 8 of section 8 of chapter 75 of the Revised Laws provides that cane sugar may be used as a preservative in food preparations without its presence being indicated upon the label as being an adulteration. As a result, the courts have ruled that receptacles containing compounds of maple sugar, honey, cocoa, etc., with cane sugar (which cane sugar is manifestly present in an effort to cheapen the product), need not bear upon the labels a statement of the presence in such compounds of cane sugar, or its percentage.

Inasmuch as this practice is manifestly an effort to evade the spirit of the law concerning the adulteration of food products, the Board recommends that legislation be enacted requiring that the proportion of cane sugar in such compounds be indicated upon the labels thereof, in accordance with section 19 of chapter 75 of the Revised Laws.

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[1] Prohibition of sale later removed.

Routine Work of the Board.

Statistical Table for the Year ended Nov. 30, 1909.

Whole number of samples of food and drugs examined,	6,310
Samples of milk examined (included in the foregoing),	3,584
Whole number of samples of food and drugs examined since beginning of work in 1883,	189,593
Whole number of samples of milk examined since beginning of work in 1883,	104,581
Number of prosecutions against offenders during the year,	296
Number of convictions during the year,	267
Amount of fines imposed,	$5,666.74
Number of dairies examined,	1,771
Number of packages of antitoxin of 1,500 units each issued to cities and towns,	90,131
Number of tubes of vaccine issued to cities and towns,	47,961
Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns,	4,123
Number of examinations made for diagnosis of tuberculosis,	2,013
Number of examinations of blood made for diagnosis of malarial infection,	43
Number of examinations of blood made for the diagnosis of typhoid fever,	830
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 75, section 52, Revised Laws,	43,205

Force employed in general work of Board at central office, State House: —	
Secretary,	1
Assistant to the secretary,	1
Clerks,	6
Messengers,	2
Sanitary inspector of dairies,	1
Total,	11

Force employed for food and drug inspection: —	
Chemists and assistants,	4
Inspectors,	4
Total,	8

Force employed at laboratory (Bussey Institution): —	
Pathologist,	1
Assistants,	6
Total,	7

Under the Provisions of Sections 112 to 118 of Chapter 75, Revised Laws.

Applications for advice from cities, towns and others: —	
Relating to water supply,	88
Relating to ice supply,	6
Relating to sewerage and drainage,	22
Relating to pollution of streams,	9
Miscellaneous,	3
Total,	128

Number of samples of water, ice and sewage examined chemically and microscopically at the laboratory, Room 502, State House,	6,709
Number of samples of water, sewage, ice, etc., examined chemically and bacterially at Lawrence Experiment Station,	2,422
Number of samples of water, sewage and ice examined bacterially,	6,661
Number of samples of sand examined chemically and mechanically,	33
Number of samples of sand examined chemically only,	235
Number of samples of sand examined mechanically only,	39
Total number of samples examined,	16,099

Force employed at central office: —		
Chief engineer,	1	
Assistant engineers,	12	
Stenographers and clerks,	4	
Messenger,	1	
	—	18
Force employed at laboratory, Room 502, State House: —		
Chemist,	1	
Assistant chemists,	7	
Biologist,	1	
Stenographer,	1	
	—	10
Force employed at Lawrence Experiment Station: —		
Assistant chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	3	
	—	7
Total ordinary force,		35

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows: —

1886,	8	1899,	79
1887,	22	1900,	104
1888,	28	1901,	105
1889,	38	1902,	93
1890,	23	1903,	129
1891,	53	1904,	125
1892,	56	1905,	105
1893,	51	1906,	130
1894,	53	1907,	125
1895,	52	1908,	134
1896,	65	1909,	128
1897,	59		
1898,	75	Total,	1,840

Appropriations.

The appropriations for the year ended Nov. 30, 1909, as recommended by the Board in the annual estimates made under the provisions of chapter 6, section 26, of the Revised Laws, were as follows: —

For the general expenses of the Board,	$27,500 00
For the inspection of food and drugs,	14,500 00
For the production and distribution of antitoxin and vaccine,	20,000 00
For the purity of inland waters,	36,000 00
For the examination of sewer outlets and Neponset River,	12,000 00
For printing the annual report,	3,000 00
State Inspectors of Health,	30,000 00
Total,	$143,000 00

Expenditures.

The expenditures under the different appropriations for the year ended Nov. 30, 1909, were as follows: —

General Expenditures.

Appropriation,	$27,500 00
Salaries,	$13,856 67
Travelling expenses,	2,869 76
Amount carried forward,	$16,726 43

Amount brought forward,	$16,726 43
Stationery,	493 44
Printing,	2,221 54
Books, subscriptions and binding,	767 03
Advertising,	79 48
Express charges,	57 28
Extra services,	257 52
Messenger,	164 40
Postage and postal orders,	2,015 44
Telephone and telegraph messages,	176 52
Typewriting supplies,	223 25
Special investigations,	94 36
Sundry office supplies,	464 14
Laboratory supplies,	869 03
Labor and materials,	222 99
	$24,832 85

Expenditures for the Production and Distribution of Antitoxin and Vaccine for the Year ended Nov. 30, 1909.

Appropriation,	$20,000 00
Salaries,	$7,149 17
Printing,	244 88
Books and stationery,	50 68
Laboratory supplies,	3,185 53
Laboratory construction,	553 60
Rent of laboratory and stable,	2,510 40
Express charges,	38 35
Travelling,	6 65
Purchase of animals,	1,075 47
Board of horses,	15 00
Services of veterinary,	10 00
Food for animals,	3,107 63
Rental of telephone, messages and postage,	162 00
Extra services,	93 55
Ice,	110 73
Gas, electric lighting, heating and water,	344 95
Miscellaneous,	124 66
Total,	$18,783 25

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1909.

Appropriation,	$14,500 00
Salaries of analysts,	$5,800 00
Salaries of inspectors,	5,025 55
Travelling expenses and purchase of samples,	2,813 43
Apparatus and chemicals,	299 26
Printing,	91 77
Services, cleaning laboratory,	104 00
Express, telephone and telegraph messages,	12 47
Sundry laboratory supplies,	86 56
Books, binding and stationery,	40 60
Extra services,	98 67
Advertising,	58 89
Miscellaneous,	93
Total,	$14,432 13

For carrying out the Provisions of the Act to protect the Purity of Inland Waters, and to require Consultation with the State Board of Health regarding the Establishment of Systems of Water Supply, Drainage and Sewerage.

Appropriation for the year ended Nov. 30, 1909,	$36,000 00
Credit by amount returned to the State Treasurer,	1 00
	$36,001 00
Salaries, including wages of laborers at Lawrence Experiment Station,	$28,111 24
Apparatus and materials,	1,958 81
Rent of Lawrence Experiment Station,	150 00
Repairs and maintenance, Lawrence Experiment Station,	356 82
Travelling expenses,	1,508 06
Express charges,	1,747 76
Books and binding,	394 58
Maps and blue prints,	254 52
Stationery, drawing materials and typewriting supplies,	759 15
Telephone and telegraph messages and postage,	167 13
Extra services,	314 75
Services, collecting samples and reading gauges,	66 60
Miscellaneous,	211 01
Total,	$36,000 43

For the Examination of Sewer Outlets, under the Provisions of Section 4 of Chapter 75 of the Revised Laws.

Appropriation for the year ended Nov. 30, 1909,	$12,000 00
Salaries, including wages of laborers at Lawrence Experiment Station,	$8,919 88
Apparatus and materials,	422 41
Repairs and maintenance, Lawrence Experiment Station,	61 50
Labor,	16 50
Travelling expenses,	1,689 52
Express charges,	102 47
Telephone and telegraph messages and postage,	65 45
Extra services,	252 69
Services, collecting samples and reading gauges,	114 35
Books, maps and blue prints,	230 47
Stationery, drawing materials and typewriting supplies,	43 24
Miscellaneous,	78 27
Total,	$11,996 75

Expenditures under the Provisions of the Act to provide for the Establishment of Health Districts and the Appointment of Inspectors of Health.

Appropriation,	$30,000 00
Salaries,	$24,961 11
Travelling expenses,	1,987 11
Express charges,	19 40
Printing,	350 24
Books and stationery,	164 00
Postage,	318 49
Typewriter supplies and typewriting,	235 90
Office supplies,	57 90
Telephone and telegraph messages,	55 60
Extra services,	1,012 17
Maps and blue prints,	9 51
Miscellaneous,	4 81
Total,	$29,176 24

For carrying out the Provisions of the Act relative to the Board of Approval of Sewerage Works in the Watershed of the Charles River Basin by the City of Boston, Chapter 376 of the Acts of 1908.

Appropriation for the year ended Nov. 30, 1909,	$1,800 00
Balance from 1908 appropriation,	78 55
	$1,878 55

Salaries,	$1,830 00
Travelling expenses,	8 10
Express charges,	14 30
Drawing materials,	8 11
Maps and blue prints,	17 64
Total,	$1,878 15

For carrying out the Provisions of the Act relative to the Supervision of the Business of Plumbing, Chapter 536 of the Acts of 1909.

Appropriation, June 15 to Nov. 30, 1909,	$1,600 00

Salary, clerk,	$720 43
Travelling expenses,	154 95
Express charges,	11 74
Printing,	86 69
Postage,	62 00
Books and stationery,	111 90
Plumbers' materials,	113 81
Cleaning,	6 25
Extra services,	21 15
Office supplies,	46 50
Wages, second and third examiners,	255 00
Miscellaneous,	2 27
Total,	$1,592 69

HENRY P. WALCOTT.
JULIAN A. MEAD.
CHARLES H. PORTER.
JAMES W. HULL.
GERARD C. TOBEY.
ROBERT W. LOVETT.
HIRAM F. MILLS.

SUPPLEMENT.

Water Supply and Sewerage.

Advice to Cities, Towns and Persons.

ADVICE TO CITIES, TOWNS AND PERSONS.

Under the provisions of the Revised Laws (chapter 75, section 117), the State Board of Health is required to

consult with and advise the authorities of cities and towns and persons having, or about to have, systems of water supply, drainage or sewerage, as to the most appropriate source of water supply, and the best method of assuring its purity or as to the best method of disposing of their drainage or sewage with reference to the existing and future needs of other cities, towns or persons which may be affected thereby. It shall also consult with and advise persons engaged or intending to engage in any manufacturing or other business whose drainage or sewage may tend to pollute any inland water as to the best method of preventing such pollution, and it may conduct experiments to determine the best methods of the purification or disposal of drainage or sewage. No person shall be required to bear the expense of such consultation, advice or experiments. Cities, towns and persons shall submit to said board for its advice their proposed system of water supply or of the disposal of drainage or sewage, and all petitions to the general court for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of said board thereon.

During the year 1909 the Board has given its advice to the following cities, towns and persons who have applied for such advice under the provisions of this law or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply and to sources of ice supply, as follows: —

WATER SUPPLY.

Agawam.
Amesbury.
Amherst.
Arlington (Standard Jewelry Company).
Ashby.
Auburn (well in Pondville).
Barre.
Belchertown (Belchertown Fire District).
Blandford (Blandford Fire District).
Boston (Boylston Brewery).
Cambridge (well).

Canton.
Canton (Massachusetts Hospital School).
Chicopee (Fairview).
Chicopee (Ames Sword Company).
Cohasset.
Douglas.
Dudley.
East Bridgewater (well in Beaver).
East Bridgewater (wells).
Fairhaven (well at Wigwam Beach).
Fitchburg.
Framingham.
Framingham (well in Saxonville).
Framingham (Framingham Shoe Company).
Franklin (two).
Gardner.
Gloucester (wells).
Goshen (well).
Grafton.
Grafton (spring in Saundersville).
Grafton (Grafton Colony for the Insane).
Granville (Granville Centre).
Hadley (Hadley Water Supply District).
Hopkinton (two).
Huntington.
Kingston (well).
Lakeville (King Philip Spring).
Lanesborough.
Lawrence (well at Central Fire Station).
Lawrence (well).
Leicester (Cherry Valley and Rochdale) (two).
Leicester (Leicester Polar Spring).
Lincoln.
Littleton (wells).
Lynn (springs) (two).
Lynn (Lydia E. Pinkham Medicine Company).
Lynnfield (Sagamore Spring).
Manchester.
Mansfield (well in East Mansfield).
Marion (wells).
Medfield (Medfield Insane Asylum).
Millbury.
North Reading (well at railroad station).
North Reading (Martin's Brook Sanatorium).
Norton (Wheaton Seminary).
Palmer (Boston Duck Company).
Palmer (well of Thorndike Company).
Palmer (wells).
Peabody.
Peabody (well in Wilson Square).
Pittsfield (three).
Plainville.
Plymouth (Elder Brewster Spring).
Plymouth (George Mabbett & Sons).
Reading.
Reading (well).
Reading (well of O. P. Symonds & Sons).
Rowley (Hillcrest Spring).
Salem (G. C. Vaughn Leather Company).
Seekonk (well).
Shelburne (Shelburne Falls Fire District).
Somerset (wells).
Southborough.
Springfield (Bircham Bend Spring).
Stockbridge.
Wareham (well at almshouse).
Westfield (Westfield State Sanatorium).
Weston.
Westwood (wells in Islington).
Weymouth (Crystal Rock Spring) (two).
Winchendon (William Brown & Sons).
Winchendon (Nelson D. White & Sons).
Winchester.

Ice Supply.

Danvers.
Lexington.
Malden.
Melrose.
Quincy.
Rockland.
Williamstown.
Winchendon.

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows: —

Adams.
Amesbury.
Amherst.
Canton (Massachusetts Hospital School).
Dracut (American Woolen Company).
Hudson (four).
Lancaster (Lyman and Industrial Schools).
Lenox.
Maynard (American Woolen Company).
Monson.
Monson (Massachusetts Hospital for Epileptics).
New Bedford.
North Attleborough.
Norwood (Winslow Bros. & Smith Company).
Palmer.
Quincy.
Revere (Revere Beach).
Rutland (State Sanatorium).
Templeton (Templeton Inn).
Westborough (three).
Westborough (Hickey-Riedeman Company).

Miscellaneous.

Adams (pollution of Hoosick River).
Amesbury (pollution of Powow River).
Brockton (Brockton Gas Light Company).
Brockton (Empire Laundry Company).
Brockton (Hide-ite Leather Company).
Concord (pollution of Assabet River).
East Bridgewater (pollution of Matfield River).
Framingham (Louis Hill).
Lawrence (pollution of Spicket River).
Maynard (pollution of Assabet River).
Maynard (American Woolen Company).
New Bedford.
North Adams (pollution of Hoosick River).
Salem and Peabody (pollution of North River).
Williamstown (pollution of Hoosick River).

Water Supply.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to water supply: —

Agawam.

Feb. 4, 1909.

To the Board of Water Commissioners of the Town of Agawam, Henry E. Bodurtha, *Chairman.*

Gentlemen: — The State Board of Health has considered your application for its approval under the provisions of chapter 353 of the Acts of the year 1905 of the purchase of water for the supply of the town of Agawam from the town of West Springfield. It appears that the necessary works for distributing water in the village of Agawam have already been constructed and that water from the West Springfield system is now supplied to approximately 400 of the inhabitants of the village of Mittineague in Agawam, adjacent to the town of West Springfield.

Under the existing conditions there appears to the Board no more appropriate source from which the town of Agawam can obtain a supply of water for domestic purposes than the works of the West Springfield water supply system. The Board approves the purchase of water for the supply of Agawam from the town of West Springfield under the provisions of chapter 353 of the Acts of the year 1905.

Amesbury.

Nov. 4, 1909.

To the Board of Water Commissioners of the Town of Amesbury.

Gentlemen: — In response to your request for an examination of the water of the Dow Farm Spring, so called, and advice as to the propriety of taking water from this spring or the ground about it as an additional supply for the town of Amesbury, the Board has caused the spring and its surroundings to be examined and samples of its water to be analyzed.

The results of the examinations indicate that water of good quality for domestic purposes can probably be obtained from the ground in this locality. The watershed from which water drains toward this spring is evidently very limited in area, and the quantity of water that can be obtained from the spring or the ground in its neighborhood is likely to be so small as to make it inadvisable, in the opinion of the Board, to construct works for taking water from this source as an additional supply for the town.

The experience of the past two years has shown that the quantity

of water which your present sources are capable of yielding is no greater than is necessary for the present requirements of the town, and an additional supply should be provided without delay.

Numerous analyses of the water of your present sources, covering a period of several years, show that the quality of the water supplied by the basins and wells near Main Street, from which a large portion of your present supply is obtained, has deteriorated greatly within the past few years and is now affected by the presence of so great a quantity of iron as to make it objectionable for domestic purposes. The wells are also exposed to danger of pollution from the large population in their neighborhood.

The Board recommends that you make a thorough investigation of all of the sources available for the use of the town with a view to the selection of a source which will furnish a sufficient quantity of water to make it practicable to provide for the increasing requirements of the town and at the same time discontinue the further use of the basins and wells near Main Street. These investigations should be begun as soon as possible, and the Board recommends that they be made under the direction of an engineer of experience in matters relating to water supply. The Board will assist you in the further investigations by making the necessary analyses of water and will give you further advice when you have the results of further investigations to present.

Amherst.

Sept. 2, 1909.

To the Amherst Water Company, Amherst, Mass.

Gentlemen: — The State Board of Health received from you on July 20, 1909, the following application for its approval of the location of a proposed dam and reservoir for increasing the water supply of the town of Amherst: —

By chapter 509 of the Acts of 1909 the Amherst Water Company is authorized to build a new dam and reservoir, subject to the approval of the State Board of Health.

Plans have been prepared for creating a small reservoir for storage purposes only by the construction of a dam across Amethyst Brook about half a mile above the present intake reservoir. The maximum depth of water in the reservoir will be 30 feet, the area flooded 4.7 acres and the storage capacity 18 million gallons. The area to be flooded is to be cleared of all stumps, roots, loam and other material containing large amounts of organic matter.

Your advice with reference to and approval of the location and construction of the dam as proposed is requested under the provisions of the act above referred to.

The Board has caused the location of the proposed dam and reservoir to be examined by its engineer and has considered the plans and information presented.

It is evident that the quantity of water which is now being drawn from the present sources for the supply of the town is greater than the capacity of those sources in a very dry year, and that in order to prevent danger of a very serious shortage of water in dry seasons, it is important to increase the capacity of the works. The construction of the proposed new reservoir will increase considerably the supply of water available for the town and appears to the Board to be the most appropriate method of increasing the water supply at the present time. The location of the dam and reservoir is a suitable one for the purpose, and if the ground is cleared of vegetable matter and objectionable soil, the quality of the water should be satisfactory. The Board approves the location of the dam and reservoir under the provisions of chapter 509 of the Acts of the year 1909.

In order to construct the proposed new dam and reservoir it will be necessary to introduce a considerable number of laborers and others into the watershed above the point at which the water is now diverted for the supply of the town, and the Board recommends that you provide efficient inspection and take such other measures as will prevent danger of pollution of the water supply.

The increase in the quantity of water available for the supply of Amherst that will be obtained by the construction of the proposed reservoir, while considerable, will probably not be sufficient for the supply of the town for a very long time in the future if a large quantity of water is lost by leakage from the supply pipes or is wasted by consumers. There are indications that the quantity of water now supplied to the town is considerably larger than is necessary and it is very important, in the opinion of the Board, that the quantity of water used shall be definitely ascertained. The Board recommends that in connection with the construction of the new reservoir a Venturi meter or other means be provided by which the quantity of water supplied to the town can be accurately measured and that records thereof be carefully kept. If it should be found that the quantity of water used is excessive, further investigations should be made to determine whether the loss is caused by leakage from the pipes or waste by consumers and further measures then taken to prevent such loss or waste.

Ashby.

To Mr. W. O. Loveland *and Others, Ashby.* Nov. 4, 1909.

Gentlemen: — In response to your request for an examination of the water of Tarbell's Spring, so called, located near Mill Village, and advice as to the practicability of obtaining from this source and other springs in its neighborhood a supply of good water sufficient for the requirements of the villages of Ashby and Mill Village, the Board has caused the spring and its surroundings to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water of this spring, though probably safe for drinking in its present state, is exposed to possible danger of pollution from dwelling houses situated near by on higher land, and observations of the flow of water indicate that the quantity would not be sufficient for the supply of the villages after water comes into general use. In view of these conditions the Board cannot recommend the use of this spring as a source of domestic water supply.

It is possible for the town to obtain a supply of water by gravity from the head waters of the Souhegan River, but the source is not a desirable one for the town of Ashby to select on account of its exposure to danger of pollution. It is also possible that a supply might be obtained by gravity from one of the streams near Blood Hill, but further investigations would be necessary before the practicability of obtaining a supply from that region could be determined.

A ground water would be more satisfactory than water taken from any of the streams or ponds in this region, and if a suitable place for obtaining a sufficient quantity of good water from the ground by means of wells can be found within a reasonable distance of either of the villages, this plan would probably be the most satisfactory one for the town to adopt.

The conditions appear to be favorable for obtaining a satisfactory ground water supply in the neighborhood of the Ashby Reservoir, about two miles southwest of Mill Village, and it is possible that conditions favorable for obtaining a good supply of ground water can be found at other places at a less distance from the villages.

The Board recommends that you cause an investigation to be made in the region about the villages with the view to obtaining a water supply from the ground by means of wells or other suitable works. The investigation should be made under the direction of an engineer of experience in matters relating to water supply, and the Board will assist you by making the necessary analyses of water and will give you further advice when you have the results of further investigations to present.

Barre.

Nov. 4, 1909.

To the Board of Water Commissioners of the Town of Barre.

Gentlemen: — The State Board of Health received from you on Oct. 23, 1909, an application requesting its approval of the taking of water from Allen's Pond, so called, situated on Prince River, about half a mile north of Barre Center, as a temporary water supply for the town of Barre, and in response to this application has caused the pond and its surroundings to be examined by one of its engineers and a sample of the water to be analyzed.

The results of the analysis show that the water is highly colored and contains a larger quantity of organic matter than is found in good surface waters, due no doubt to the contact of the water with the vegetable matter in the swamps above the pond. The watershed contains but few dwelling houses, however, which are as a rule remote from the streams.

The need of an additional water supply for immediate use appears to be a very pressing one, and under the circumstances the Board approves the taking of water from Allen's Pond as a temporary water supply for the town of Barre, to meet the present emergency, under the provisions of chapter 25, section 35, of the Revised Laws. By the terms of that statute, the use of a pond as a temporary source of water supply cannot be continued for more than six months in any year.

The experience of the past two years shows that the present sources of water supply of the town of Barre are incapable of furnishing a sufficient quantity of water for the requirements of the town in dry seasons. The Board recommends that an additional supply of water of good quality sufficient for all requirements be provided as soon as practicable.

Belchertown (Belchertown Fire District).

Feb. 4, 1909.

To the Board of Water Commissioners of the Belchertown Fire District, Belchertown, Mass.

Gentlemen: — The State Board of Health received from you on Dec. 14, 1908, an application for advice as to a water supply for the Belchertown Fire District, accompanied by a report of your engineer giving results of examinations of Pratt Brook and Chambray Brook and estimates of the cost of a water supply for the district to be taken either from Chambray Brook or from the ground near Dyer's millpond about three-quarters of a mile east of the village.

Measurements of the flow of Pratt Brook and Chambray Brook during

the summer and autumn of 1908 have also been submitted, the results showing that the flow of Pratt Brook at the point at which its waters might be diverted for the supply of the district fell to about 18,000 gallons per day in the latter part of September, while the yield of Chambray Brook at the point at which it could be diverted amounted at the same time to a minimum of about 51,000 gallons per day.

The Board has caused the sources of supply indicated to be examined by one of its engineers and samples of water from Pratt and Chambray brooks and from springs near Dyer's millpond to be analyzed.

It is evident from the very low flow of Pratt Brook during the past summer and the small size of its watershed at the point at which it could be diverted for supplying Belchertown by gravity, that it is impracticable to obtain a supply of water from that source adequate for the requirements of the district. Chambray Brook above the point at which it could be diverted to supply the district by gravity drains an area of a little over half a square mile, and it is evident from measurements of the flow of the brook during the past very dry season that the natural flow of the stream would be insufficient for the requirements of the district at all times after water comes into general use.

If a storage reservoir having a capacity of about 10,000,000 gallons can be constructed upon Chambray Brook, its capacity could be increased so that it might be depended upon to yield enough water for the present requirements of the district. It is not possible, however, at this season of the year to make such an examination of the brook as would show definitely whether it is practicable to construct upon it a suitable storage reservoir of the capacity indicated at a reasonable cost.

The water of Chambray Brook, as shown by analysis, is naturally of good quality for water supply purposes. It evidently contains at some seasons of the year considerable color and organic matter, and if a reservoir should be constructed on this brook of the size indicated, it would be very important that it should be thoroughly cleaned by the removal of all the soil and organic matter from the area to be flowed in order to prevent, so far as practicable, deterioration of the water from organic growths and the disagreeable tastes and odors which they produce. It will also be necessary to take measures to prevent danger of pollution of the water from the buildings on the watershed, one group of which at least is near the brook, before this stream can be used with safety as a source of domestic water supply.

An analysis of the water of a spring near Dyer's millpond and an examination of the locality indicate that the water filtering through the ground past the dam of that millpond is affected by the presence of an excessive quantity of iron which would make it objectionable for many

domestic purposes. The conditions elsewhere in the neighborhood of this brook above and below the pond appear, however, to be favorable for obtaining water freely from the ground by means of tubular wells, and it is likely that the water would be of good quality if the wells or collecting works were properly located.

From the information submitted it appears that the first cost of works for taking water from Chambray Brook would be about $3,000 greater than from the ground near Dyer's millpond. It is evident, however, that the cost of a reservoir of the size necessary to provide an adequate water supply from Chambray Brook will increase materially the estimates presented, and a further increase will be necessary to provide for the protection of the purity of the water of that brook. Under the circumstances, it is not unlikely that the total cost of the works necessary for obtaining an adequate supply of water from Chambray Brook will be nearly, if not quite, as great as the cost of works for taking water from the ground in the vicinity of Dyer's millpond or at some other point along Jabish Brook including the cost of pumping.

The Board recommends that as soon as conditions are favorable for thorough investigation, a careful examination of Chambray Brook be made to determine the feasibility of constructing a reservoir upon it near the proposed point of diversion holding at least 10,000,000 gallons and the probable cost of the work, including the removal of all soil and organic matter from the area to be flowed. The probable cost of purchasing the necessary land and buildings or of doing such other work as may be necessary to protect the water from pollution should also be determined as closely as practicable. The Board also recommends that tests be made with a view to determine the practicability of obtaining a water supply from the ground in the vicinity of Dyer's millpond or elsewhere in the valley of Jabish Brook where the conditions appear to be favorable for that purpose. The Board will assist you in further investigations by making the necessary analyses of water and will give you further advice as to plans for securing a water supply for the district when you have the results of further investigations to present.

Blandford (Blandford Fire District).

March 4, 1909.

To the Blandford Fire District, Messrs. I. E. Whitney, E. W. Bennett and S. H. Peebles.

Gentlemen: — The State Board of Health received from you on Oct. 22, 1908, an application for the approval of a proposed water supply for the village of Blandford, to be taken from the head waters of Freeland Brook, accompanied by plans and a report of your engineer

describing the proposed works. The plans provide for constructing a small open reservoir by means of a dam to be located on the southerly branch of the brook about 2,000 feet northeast of the agricultural fair grounds and half a mile from North Street, from which water is to be pumped to a covered reservoir west of North Street and thence distributed to the village.

Analyses of the water of the south branch of Freeland Brook show that it is naturally of good quality for water supply purposes. The brook is exposed to danger of pollution from a dwelling house with outbuildings on its watershed, but the plan submitted provides for collecting all of the sewage and foul drainage from these buildings into a cesspool, from which it is proposed to convey it through a pipe sewer to a place of disposal outside the watershed of the proposed sources of water supply.

The Board has caused the locality to be examined by its engineer and has examined the plans and information submitted therewith. The water of the south branch of Freeland Brook, as shown by recent analyses, is naturally of good quality for water supply purposes, and if the possibility of pollution from the house on the watershed shall be prevented by the construction of a tight cesspool and a suitable drain for conveying all the sewage from this house to a point outside the watershed, the water of the brook can safely be used for drinking and other domestic purposes.

The flow of the brook at the site of the proposed dam in dry weather in the summer of 1907 amounted to about 12,000 gallons per day, and in the very dry period in the latter part of 1908 your engineer states that the flow fell to about 9,000 gallons per day. It is estimated that the permanent population of the village is 85 and the population in summer about 300, and the natural flow of the stream in dry weather would consequently provide only from 30 to 40 gallons per person in the summer season. That quantity, however, would be sufficient for present needs, and excepting in the driest weather, the supply from this source will doubtless be ample for the present requirements of the village.

It is possible to enlarge the yield of the proposed source by constructing a storage reservoir, but the flow of the brook in the summer season is evidently derived largely from springs and the water would be likely to deteriorate considerably in quality if exposed to light in an open storage reservoir.

An examination of the region indicates that a large additional supply can be obtained if necessary from the north branch of Freeland Brook, and as the valley of that stream is free from population, there is no reason to doubt that water of excellent quality can be obtained there.

It is in fact a more desirable source than the south branch of the brook, on account of the fact that its watershed is uninhabited, but the cost of works for taking a supply from that source would be greater than in the case of the source proposed.

Considering the circumstances, the Board, under the provisions of chapter 283 of the Acts of the year 1908, approves the taking of water from the south branch of Freeland Brook as a water supply for the Blandford Fire District. This plan includes the construction of the necessary drains, cesspool and sewer to divert the sewage from the farm buildings in the valley of the brook to a place of disposal outside the watershed from which the water supply is to be taken.

CANTON.

To the Board of Health of the Town of Canton. DEC. 7, 1909.

GENTLEMEN: — In accordance with your request the State Board of Health has caused the wells from which the town of Canton obtains its water supply to be examined and samples of water collected from these wells at various times and from faucets in different parts of the town to be analyzed to determine the cause of the numerous complaints made recently as to the character of the water and a remedy for the objectionable conditions which were the cause of these complaints.

Samples of water have been collected at frequent intervals, both from the wells at Springdale and at Henry's Spring, since these sources were first used, and the sources have been inspected from time to time by the engineers of the Board.

The well at Springdale — the original source of water supply of the town of Canton — furnished a water of good quality, free from an excess of iron; but the quantity which the well yielded was so limited that soon after its completion a new well was constructed at Henry's Spring from which the water is delivered by gravity through a cast-iron pipe about 1.5 miles in length into the Springdale well.

The water of the well at Henry's Spring when first used differed but little in quality from that of the Springdale well, and water supplied to the town, which is a mixture of water from these two sources, was for many years of good quality and unaffected by iron.

Inspections of the well at Henry's Spring from time to time in the past few years have shown that during the summer season the water at the surface at least was turbid and highly colored, being affected by the presence of an excess of iron, but in the winter season the turbidity disappeared although a deposit of flocculent sediment, resembling iron rust, gradually accumulated in the bottom of the well.

Careful examinations made during the past year indicate that, while

the water entering the well doubtless comes chiefly through the gravel at its bottom, a considerable quantity enters through cracks in the walls near the surface, and analysis shows that this water contains iron in large quantity which quickly oxidizes upon exposure to the air. The water in the bottom of the well has thus far apparently contained comparatively little iron in the summer season. It is also found that the temperature of the water of the Henry's Spring well is considerably higher at the surface during the summer than at the bottom, and there has apparently been no circulation of water in this well in the summer season, so that the layer of water containing the greatest excess of iron has remained at the surface. Late in the autumn, as the water becomes cooler and circulation is established in the well, the water near the surface becomes much clearer and the flocculent, rusty, suspended matter sinks to the bottom.

During the past very dry season the water of the Springdale well, supplemented with such water as would flow through the gravity pipe line from Henry's Spring, became insufficient for the supply of the town, and it became necessary to set up a pump at the Henry's Spring well and force water in larger quantity through the main to Springdale. In consequence, it is probable that considerable quantities of flocculent iron deposited in the bottom of the well and probably to some extent in the pipe line were forced into the well at Springdale and thence into the distributing system. The presence of this matter in the water, while probably not injurious to health, makes the water very objectionable for many domestic purposes, and it is to this condition that the recent complaints of the water have been due.

Iron is present in water in various forms, and in this case it is probably dissolved in the water and is oxidized on exposure to the air in the well and thus produces the objectionable turbidity and sediment that are found there in the summer season.

Experience with wells affected in this way shows that the quantity of iron present in the water tends to increase with continued use, and, since it is likely that the quantity of water required from the well at Henry's Spring will gradually increase in the future, its quality is likely to continue to deteriorate.

Various methods of removing iron have been tried, and there is no reason to doubt that it can be removed from this water by aeration and filtration and the water rendered satisfactory in all respects.

An attempt has been made to clean out the well at Henry's Spring, but this does not appear thus far to have been successful. It is improbable, however, that the cleaning out of the well would effect a permanent improvement in the quality of the water.

From such information as is available as to the character of the soil in which this well is situated it appears that in close proximity to the well there is a deep layer of peaty soil, and it is likely that the excess of iron is brought into the well by water which has been in contact with this peaty deposit. It is possible that the removal of this material from the neighborhood of the well might effect an improvement in the quality of the water, but the expense of such an undertaking would be large and the result uncertain.

A general examination of the ground about Henry's Spring and along the pipe line leading to the well at Springdale indicates that the soil over a wide area in this region is coarse and porous and that the conditions are very favorable for obtaining water from the ground in large quantity. It is probable that, by the construction of another well or a system of tubular wells in this region at no great distance from the present sources or the pipe line leading to Springdale, an ample supply of good water, free from an excess of iron, can be obtained at a comparatively small expense.

Considering all the circumstances, it appears to the Board likely that the least expensive and most satisfactory plan of obtaining relief from the objectionable conditions that have affected the water supply of the town during the past summer and providing a water which will be of good quality at all times, will be to take water from a well or group of wells in the neighborhood of the Henry's Spring or the pipe line leading to Springdale.

The Board recommends that the town cause an investigation to be made by sinking test wells in this locality, and if conditions favorable to obtaining water of good quality and in sufficient quantity for the requirements of the town are found at any point in this region, it will be advisable to put in a group of wells and pump from them for a period of about two weeks to determine the probable quality of the water and the practicability of obtaining from them enough water for the requirements of the town. It is important that these investigations shall be made under the advice of an engineer of experience in matters relating to ground water supplies, and the Board will assist you by making the necessary analyses of water and give you further advice when you have the results of further investigations to present.

Canton (Massachusetts Hospital School).

July 1, 1909.

To the Board of Trustees of the Massachusetts Hospital School, Canton, Mass.,
Dr. E. H. Bradford, *Chairman.*

Gentlemen: — The State Board of Health received from you on June 11, 1909, the following communication for advice as to a ground water supply for the institution to be taken from wells in the hospital grounds: —

As chairman of the Board of Trustees of the Massachusetts State Hospital at Canton, I write to ask the advice of your Board.

In the close vicinity of the lands occupied by our institution is a cemetery, situated at a lower level than the site of the land occupied by our buildings. The proprietors of this cemetery have recently purchased land nearer our institution, and at a higher level. In view of the fact that it will be necessary for our institution soon to sink artesian wells for a water supply, it is desirable to ascertain whether the new location of the cemetery will in any way be injurious or detrimental to the health of the inmates of our institution.

Artesian wells are made necessary by the fact that the water supplied by the town has been found injurious to boilers, and is said not to be generally used by the factories of the town. As the cost of the water supplied by the town is high, it has been thought that it might be desirable to make use of water from artesian wells for drinking purposes also. The Board wishes me, therefore, to request you, after examining the premises to report to us in the matter.

It appears from a further communication that the land which it is proposed to use for a cemetery lies on the northerly side of Randolph Street and extends from Washington Street east practically to a point opposite the easterly limits of the land of the hospital.

The Board has caused the locality to be examined by its engineer and has considered the practicability of obtaining a water supply for the institution from wells on the hospital grounds, and the possible effect upon such a supply of the use of the lands indicated for cemetery purposes.

An examination of the topographical map of the State and of the surveys of the hospital grounds indicates that Randolph Street, which forms the northerly boundary of the grounds, follows approximately in this locality the line of the watershed between Reservoir Pond on the southeast and a small brook draining into the Neponset River on the northwest, and that the highest lands within the hospital grounds and those of the proposed cemetery border this street. North of Randolph

Street in this region the ground, while very uneven, slopes off quite rapidly to the valley of the small brook already referred to, falling 100 feet in about one-quarter of a mile. Toward Reservoir Pond the ground slopes more gradually for about the same distance and the fall is not more than two-thirds as great.

The soil in the lands of the hospital and in those of the proposed cemetery, as well as in other lands about them, appears to be coarse and porous, so far as can be judged from surface indications, but no tests have thus far been made to determine definitely the character of the soil beneath the surface, the depth to ground water or the practicability of obtaining water in considerable quantity from the ground in this locality.

Judging from the topographical and surface indications, the most favorable place in which to obtain a well water supply within the hospital grounds would be in the neighborhood of the shore of Reservoir Pond. The sewage of the buildings is disposed of upon land near the westerly boundary of the grounds not far from the pond, and the water supply should of course be located at a sufficient distance from the sewage disposal area to prevent contamination of the water. The best place in which to look for a water supply for the institution would probably be near the easterly boundary and within 100 to 200 feet of the pond. It is improbable that water taken from the ground in this locality would be affected materially by the use of the lands northwest of Randolph Street as a cemetery.

Chicopee (Fairview).

Dec. 10, 1909.

To the Board of Water Commissioners of the City of Chicopee.

Gentlemen: — In accordance with your request the Board has analyzed the samples of water sent in by you from a group of wells located near the easterly limit of the village of Fairview, and has caused the locality to be examined by its engineer.

The wells are located in low ground, a short distance east of Church Street and not far from a populous neighborhood. In sinking the wells a stratum of peaty soil or muck appears to have been encountered in all cases. In a part of the area the muck was at the surface while in other parts it was covered with a layer of sand. The wells were sunk to depths ranging from 30 to 35 feet, penetrating, beneath the muck, various strata of coarse and fine sand.

During a period of six days, — from October 15 to October 21, — water was pumped from a group of six wells in this locality at a rate of 90,000 gallons per day, and eight samples of water, sent in by you from time to time during the test, have been analyzed.

The results of the analyses show that the water was slightly turbid

throughout the test, and that, while the water was colorless at the beginning of the test, a decided color appeared toward its end. There was also a marked increase in chlorine, nitrates and hardness during the test and the quantity of iron present was higher than is found in good ground waters.

In view of these conditions a further test has been made by pumping for three days from wells numbered 2, 3, 4, 5, 16, 17, 18 and 19 at the northerly end of the group at a rate of 115,000 gallons per day, and subsequently for three days from wells numbered 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 at the southerly end of the group, also at a rate of 115,000 gallons per day, and samples of water collected and sent in by you during these tests have been analyzed.

The results of these analyses show that the water of the northerly group of wells was of good quality and changed but little during the test, while the water of the southerly group of wells was affected by an excessive quantity of iron and was in other respects of objectionable quality.

While the water of the northerly group of wells was of good quality during the short pumping test to which they were subjected, there is danger that with continued use this water might be affected in a manner similar to that of the southerly group; and under the circumstances it is desirable to locate the wells from which the permanent supply is to be taken at a greater distance from the locality in which the wells furnished water of poor quality.

It is understood, however, that the works for distributing water are nearly completed, and in view of that fact and the difficulty of making further tests at this season of the year, you desire to use temporarily the water of the northerly group of wells, which has thus far furnished water of good quality. The Board questions the desirability of the use of these wells as permanent sources of water supply for Fairview, and if they are used temporarily in the present emergency, the Board advises that the water be analyzed at frequent intervals, in order that its use may be discontinued if deterioration occurs.

Chicopee (Ames Sword Company).

Dec. 2, 1909.

To the Board of Health of the City of Chicopee.

Gentlemen: — In response to your request for an examination of the drinking water used at the works of the Ames Sword Company in Chicopee, which you believe to be polluted, the Board has caused the locality to be examined and a sample of water collected from a faucet in these works to be analyzed.

The Board is informed that the water supplied from the Chicopee water supply system to the Ames Sword Company's works is delivered through an 8-inch pipe, leading from a large main in Chicopee Street westerly through the works of the A. G. Spaulding & Brothers' Manufacturing Company and terminating at a point in the yard of the Ames Sword Company. This pipe is also connected with another Chicopee water main in Front Street south of the canal, and near the point where this branch joins the 8-inch pipe, about 200 feet east of Chicopee Street, a fire pump is located, by which water from the canal leading from the Chicopee River can be pumped into the 8-inch main in case of fire. In order to prevent water from the canal from passing back into the city mains when the fire pump is in operation, a check valve has been placed on the 8-inch main at Chicopee Street, so arranged as to close when the pressure from the fire pump becomes greater than the pressure from the city main, and the Front Street main is also separated from the fire pump by a similar check valve.

It appears that on September 16 the fire pump was tested and canal water was evidently introduced into the 8-inch main, from which water is supplied for drinking in the Ames Sword Company's works.

The results of an analysis of the sample of water collected from a tap on the 8-inch main in the works of the Ames Sword Company show that the water was very badly polluted and differed greatly in character from the water supplied from the Chicopee water works. Later on another sample, collected on October 12, showed that the polluted water had been replaced with water from the Chicopee water works.

Water drawn from the canal by the fire pump is polluted by sewage and very dangerous for drinking, and the Board recommends that provision be made so that when the fire pump is tested water from the canal will not be introduced into any part of the main from which water may be drawn for drinking. This can be effected by pumping into a branch of the main leading to a hydrant and providing a positive gate to prevent water from flowing back into other parts of the main. When the test is over, the hydrant can be flushed and all canal water expelled from it. With such an arrangement the pumps can be properly tested, and danger of canal water entering the main at any point where it may be used for drinking can be prevented.

Cohasset.

March 4, 1909.

To the Cohasset Water Company, Cohasset, Mass.

Gentlemen: — The State Board of Health received from you on Jan. 11, 1909, an application for the approval by the Board of the taking of certain parcels of land with the right of way thereto situated on the northwesterly side of Bound Brook about half a mile north of the village of Beechwood in Cohasset, and the approval of the location of a well upon this land, and in response to this application has caused the locality to be examined by its engineer and has examined the plans and information presented.

The Board has already advised you that the plan of taking a water supply from a well in this locality, supplemented by water to be pumped upon a filter surrounding the well either from the brook or from other wells in this region, is a practicable method of securing an additional water supply of good quality for the town, and that an examination of the conditions elsewhere throughout the town does not show any more favorable locality from which to obtain an additional water supply.

Subsequent to the date of the last advice given by the Board in this matter, on May 7, 1908, it appears that pumping was again begun from the test well referred to in that communication and was continued for a period of several weeks during the latter part of 1908, at a rate of about 300,000 gallons per day. Samples of water were collected from time to time while pumping was in progress, and the results show that there was a slight deterioration in the quality of the water in some respects, due very probably to the flow toward the well of ground water of poor quality from the swamp north of it.

Considering the dryness of the season and the large quantity of water pumped during the period indicated, the results are favorable for obtaining a large additional supply of good water in this locality. The results of the recent tests indicate, however, the importance of building a filter about the well and supplying it either with water from the brook or well aerated ground water from the swamp land to the north of it before pumping large quantities of water continuously from this well. Otherwise the quality of the water of the well may deteriorate after continued use and be affected unfavorably by the waters of poorer quality in the neighborhood.

The area of land which it is proposed to take about the well is, in the opinion of the Board, a reasonable one for the protection of the purity of the supply, and the Board approves the taking of water from the well supplemented with water from the ground or brook properly filtered in

the manner described and approves the taking of the lands proposed in your application as shown upon the plan submitted, entitled "Plan of Land in the Beechwoods, Cohasset. Belonging to Lot W. Bates and Saml. E. Pratt. Scale 50 Ft. to an Inch. D. N. Tower, Engr. Jan. 1909."

The lands and right of way the taking of which is herein approved comprise about 20.5 acres, and are bounded, measured and described as follows: —

Two certain parcels of land in that part of Cohasset called Beechwoods in the County of Norfolk and Commonwealth of Massachusetts. Said parcels lie on each side of Bound Brook and lie to the North of Beechwoods Street and to the East of Doane Street. The first parcel containing Nineteen and two hundredths (19.02) acres more or less is composed of high land, woodland, field land, meadow and swamp and is bounded and described as follows, viz.: —

Beginning on said Bound Brook at the South Easterly corner of land now or formerly belonging to Ira N. Pratt, thence running Northwesterly on several courses to land now or formerly belonging to Samuel D. James and bounded Southwesterly by land now or formerly belonging to Ira N. Pratt and land now or formerly belonging to Herbert L. Brown; said bound being in part formed by a stone wall; thence turning and running Northerly and Northeasterly as the wall runs on several courses Four hundred and Seventy-five (475) feet more or less to an angle in said wall, and bounded Westerly and Northwesterly by land now or formerly belonging severally to Samuel D. James, Levi and Thomas Lincoln, Lot W. Bates, and Edwin W. Bates, thence turning and running Northwesterly again as the wall runs and continuing in the same direction Two Hundred and seventy-eight (278) feet more or less to a post at the Southwesterly corner of land now or formerly belonging to Rufus W. Bates, and bounded Southwesterly by land now or formerly belonging to Edwin W. Bates; thence turning and running Northeasterly on two courses One Hundred and nineteen (119) feet and One Hundred and Sixty (160) feet respectively more or less to a heap of stones and bounded Northwesterly by land now or formerly belonging severally to Rufus W. Bates, and Charles S. Hackett; thence turning and running a little East of South Three Hundred and twenty-eight (328) feet more or less to a post and bounded Northeasterly by land now or formerly belonging to the heirs of David W. Whitcomb; thence turning and running Easterly Four Hundred and Eleven (411) feet more or less to a post and bounded Northerly by said land belonging to the heirs of said Whitcomb; thence turning and running a little East of South Three Hundred and Seventy-nine (379) feet more or less to said Bound Brook and bounded Northeasterly by land now or formerly belonging to Bethia L. Sankey; thence turning and running in a general Southwesterly direction as said Brook runs to the point begun at, and bounded Southerly by said Brook.

The second parcel containing One and forty-nine hundredths (1.49) acres

more or less is composed of meadow land and lies South and Southeasterly of a part of the first parcel and on the opposite side of said Bound Brook and is bounded and described as follows, viz.:

Beginning on said Bound Brook at land of Lot W. Bates, which place of beginning is the same as the place of beginning in the above described first parcel; thence running Southeasterly as the stone wall runs Thirty-seven (37) feet more or less to a post in said wall and bounded Westerly by land belonging to said Lot W. Bates; thence turning and running a little East of North Five Hundred and Six (506) feet more or less to a post; thence running Northeasterly Two hundred and Eighty-six (286) feet more or less to the end of a stone wall and land now or formerly belonging to Edwin Bates, and bounded in the last courses by land belonging to Lot W. Bates; thence turning and running Northerly Eighty-seven (87) feet more or less to said Brook and bounded Easterly by said land of Edwin Bates; thence in a general Southwesterly direction as said Brook runs to the point begun at and bounded Northerly by said Brook.

Said two parcels are shown on plan entitled "Plan of land in the Beechwoods, Cohasset, belonging to Lot W. Bates and Samuel E. Pratt. D. N. Tower, Engineer, January 1909."

Together with all rights, privileges and appurtenances thereto belonging and all encumbrances and restrictions thereon.

Douglas.

Nov. 22, 1909.

To the Board of Water Commissioners of the Town of Douglas, Mr. W. R. Wallis, *Chairman.*

Gentlemen: — The State Board of Health received from you on Nov. 9, 1909, an application requesting its approval of the use of a system of tubular wells, located in the valley of a small brook about three-quarters of a mile southwest of the village of East Douglas on land now or formerly of W. R. Wallis, as sources of water supply for the town of Douglas, and in response to your application has caused the locality to be examined by its engineer and samples of water from the wells to be analyzed.

The samples of water were collected and sent in by you during a pumping test conducted between October 29 and November 8, the quantity of water pumped from the wells between November 1 and November 8, when the pumps were operated continuously, amounting to an average of about 400,000 gallons per day.

The results of the analyses show that the water is of good quality for the purposes of a public water supply. It is evidently affected somewhat by the wastes discharged upon or into the ground at a dwelling house and other buildings located on higher ground east of the wells, and doubtless to some extent also by the cultivation of the land in their neighbor-

hood; but, by taking such measures as may be necessary to prevent the further pollution of the ground water in their neighborhood, deterioration of the water of the wells can probably be prevented. It is also probable that by changing the location of the wells to the neighborhood of the place where the original test wells were located, the effect of the presence of the buildings in their neighborhood would be greatly diminished. Such a change can be made if necessary in the future without seriously affecting the works.

Considering the circumstances, the Board approves the use of water from these wells for the supply of the town of Douglas, with the recommendation that the works be arranged, so far as practicable, in such a way that water can be taken from a group of wells farther southwest in the neighborhood of the place where the original test wells were located if it shall become desirable to do so in the future.

Dudley.

Aug. 5, 1909.

To the Board of Water Commissioners of the Town of Dudley.

Gentlemen: — The State Board of Health has considered your application for the approval of the use of water from a group of tubular wells near the southwesterly side of Merino Pond as sources of water supply for the town of Dudley and has caused the locality to be examined by its engineer.

It appears that the wells from which the proposed supply is to be taken are situated in a deep depression or kettle-hole about 100 feet from the shore of the pond and have been driven to a depth of from 25 to 35 feet. The material encountered in sinking the wells was coarse and porous, and water could be pumped from them very freely.

In order to obtain further and more definite information as to the probable yield of the wells and the quality of the water a pumping test was made by pumping from a group of seven wells continuously for a period of eight days — from July 22 to July 30 — and samples of water were collected daily during the test and sent to the laboratory of the Board for analysis. The results of the analyses show that the water is of very good quality for all the purposes of a public water supply. During the test, water was pumped at an average rate of 195,000 gallons per day; and observations of the height of the water in the pond and in the various wells in the neighborhood indicate that a sufficient supply of water for all reasonable requirements of the town of Dudley can be obtained from the ground in the locality in which the test was made.

The Board approves the plan of taking water for the supply of Dudley from wells in the locality described under the provisions of chapter 252 of the Acts of the year 1909.

Fitchburg.

Nov. 10, 1909.

To the Board of Water Commissioners of the City of Fitchburg.

Gentlemen: — The State Board of Health has considered your petition for the consent and approval by this Board of the taking, by purchase or otherwise, of certain lands within the watershed of Meetinghouse Pond in the town of Westminster for the purpose of preserving and improving the quality of the water of said pond, which is used as a source of water supply by the city of Fitchburg, accompanied by a plan and description of the lands.

In response to this petition the Board gave a hearing at its office, Room 143 State House, Boston, on Oct. 14, 1909, after publishing notice of the hearing in newspapers circulating in the city of Fitchburg and the town of Westminster. After the hearing, at which no one appeared to oppose the taking of the land in question by said city, and after an examination of the lands proposed to be taken as described in your petition, the Board, upon consideration, voted to consent to and approve the taking by the city of Fitchburg of lands now or formerly of S. Dwight Simonds located westerly of Meetinghouse Pond and within the watershed thereof, amounting to about 142.61 acres, shown on the plan presented with your petition, entitled "Plan of land bought of S. Dwight Simonds by the City of Fitchburg in Westminster, Mass. 1909."

The lands, the taking of which is herein approved, are comprised in four lots, which are bounded, measured and described as follows: —

I. A lot of land situated on the westerly side of the highway from Westminster to Hubbardston and between said highway and a town way and described as follows: — Beginning at said Westminster-Hubbardston road at land now or formerly of Gertrude Baker, thence westerly on land of said Baker about 284 feet to said town road, thence northerly on said town road about 494 feet to land of the Derby estate, thence southeasterly on said Derby estate about 100 feet, thence southwesterly on same land about 72 feet, thence southeasterly on land of said Derby estate and land of one Newman about 336.3 feet to said Westminster-Hubbardston road, thence southwesterly on said road 305.9 feet to place of beginning, containing 3.19 acres of land.

II. A lot of land situated between the Westminster-Hubbardston road and other town ways and Meetinghouse Pond: — Beginning at the most northerly point on said road at land of Levi Baker at said Westminster-Hubbardston highway, thence southeasterly on land of said Baker about 654 feet to the line of the five rod taking around Meetinghouse Pond, thence on said five rod taking 34.3 feet to a stone bound numbered 33, thence southerly, easterly and northeasterly on said five rod taking 1808.3 feet to stone bound marked 22, thence northeasterly on said five rod taking 48.64 feet to land now or for-

merly of D. C. Miles, thence on land of said Miles by an irregular line which is largely indicated by stone walls, a distance of 2112.3 feet to land of one Taylor, thence southwesterly about 124 feet, thence southeasterly 265.6 feet and southeasterly 74 feet, all being on land of one Taylor and land of parties unknown to a town way, thence southwesterly by said town way 1400 feet to land of Heirs of Josiah Foster, thence northwesterly on land of said Foster Heirs as indicated by stone wall about 1639 feet to an angle, thence southwesterly on land of said Foster Heirs as indicated by stone wall about 918 feet to a town way, thence northwesterly on said town way about 389 feet to land of one Richards, thence northerly 238.2 feet, northwesterly 194 feet and southwesterly 184.8 feet, all on land of said Richards to said town way, thence northwesterly to northerly on said town way about 672.5 feet, to land of Artemus Baker, thence southeasterly 178.5 feet, northeasterly 223.6 feet and northwesterly 180.2 feet all on land of said Baker to the Westminster-Hubbardston road, thence northeasterly on said Westminster-Hubbardston road about 1259.1 feet to place of beginning, containing 79.09 acres.

III. A lot of land situated on the westerly side of the town way described as follows: — Beginning on said town way at land of the Heirs of Josiah Foster thence westerly on land of said Foster Heirs about 887.9 feet, thence northerly on land of said Foster Heirs about 598½ feet to land of one Hatstat, thence northeasterly on land of said Hatstat 359 feet to land of Margaret J. McKay, thence northeasterly on land of said McKay about 307 feet, thence northerly on land of said McKay 181.8 feet to the Westminster-Hubbardston road, thence northeasterly on said road 33.8 feet to land of one Brown, thence southerly on land of said Brown 116.2 feet, thence easterly on land of said Brown 223.1 feet to a town way, thence southerly on said town way about 916 feet to place of beginning, containing 16.03 acres of land.

IV. A lot of land situated on the northwesterly side of the Westminster-Hubbardston road and described as follows: — Beginning on said Westminster-Hubbardston road at land of Hadley and Foster, thence northwesterly on land of Hadley and Foster 695 feet, thence northwesterly on land of Richard Symonds about 1101 feet, thence in a generally northeasterly direction as the wall now is by land of one Hover and land of one Partridge about 1240.8 feet, thence southeasterly by land of Partridge and land of Damon and land of one Foster about 1063.7 feet, thence northeasterly on land of one Foster about 469.2 feet to a town way, thence southerly by said town way and said Westminster-Hubbardston road about 955 feet, thence westerly by said Westminster-Hubbardston road about 350 feet to land of Margaret McKay, thence northwesterly about 49.5 feet, southwesterly 57.8 feet, westerly 24.2 feet and southerly 115.5 feet all on land of said Margaret McKay to said Westminster-Hubbardston road, thence southwesterly on said road 232.2 feet to place of beginning, containing 44.5 acres of land.

FRAMINGHAM.

Nov. 17, 1909.

To the Board of Water Commissioners of the Town of Framingham.

GENTLEMEN: — The State Board of Health has considered your communication relative to further tests with a view to obtaining a water supply for the town of Framingham on a certain lot of land near Framingham Reservoir No. 1 of the Metropolitan water works by means of driven wells or similar works, and has caused the locality to be examined by its engineer.

The land in question is an island practically surrounded by Framingham Reservoir No. 1 and its bays and tributaries, and is located about a mile southwest of the village of Framingham Center.

So far as economy in the construction of the works for taking water from this locality is concerned it would be desirable to locate them as near the northeasterly end of the island as practicable, thus reducing the length of pipe line necessary to convey the water to the present system. The land at this end of the island is quite flat and elevated but little above the level of the water in Reservoir No. 1. The conditions, so far as can be judged from surface indications, are not unfavorable for obtaining water in large quantity from the ground at this place, but, until tests of the ground have been made, it will be impossible to determine whether water can be obtained freely from the ground in this region or not. The presence of the dwelling house and outbuildings and the fact that the land is cultivated to a considerable extent would probably have an effect upon the quality of the ground water and make it less satisfactory than water collected at a greater distance from dwelling houses. The character of the soil farther to the southwest appears to be somewhat more favorable for obtaining a ground-water supply, judging from surface indications, than at the northeasterly end of the island, and the most favorable conditions in this region apparently are found near a small bay on the southeasterly side of the island, as shown upon the State map.

The conditions for obtaining water in large quantity from the ground in this region appear to be sufficiently favorable, so far as can be judged from a superficial examination, to warrant the further tests necessary to obtaining more reliable information. These further tests should be made by sinking tubular wells at various places in this region to determine the character of the soil beneath the surface and whether a porous layer exists of such depth and extent as to indicate that a large quantity of ground water is likely to be obtainable there.

The Board recommends, as the next step in your investigations, that you sink wells at various points in the locality indicated above at the

northeasterly end of the island and at other points, especially near the bay at its southeasterly side. The character of the strata passed through in sinking each well should be carefully noted. If water is obtained freely from any of the test wells, it is desirable to collect a sample from it for analysis after pumping until the water becomes clear or nearly so.

When the results of these tests are available, it will be practicable to determine whether the conditions are sufficiently favorable to warrant further tests. If a deep stratum of porous soil is found which yields water freely and the character of the water appears to be good, it will be desirable to make a further test by putting in a group of wells and pumping from them with a steam pump for a period of probably at least two weeks and perhaps for a longer time.

If water should be obtained from this region in sufficient quantity for the requirements of Framingham, it is evident that a large proportion of it will have to come by filtration through the ground from Reservoir No. 1, and it will be essential that the test be sufficiently thorough to show whether enough water for the supply of the town can be obtained, and also whether the quality is likely to be satisfactory. It is obviously for the advantage of the town to test the proposed source of supply with sufficient thoroughness to determine quite definitely the probable quantity and quality of water that can be obtained there before the construction of works has been begun, since, if the location should prove unsatisfactory, the work done with a view to the use of this source might be wasted.

The Board will assist you in further investigations, if you so request, by making the necessary analyses of water from the test wells, and when the results of the preliminary tests are available, will upon application promptly advise you as to the desirability of further tests and their extent and character.

FRANKLIN. OCT. 21, 1909.

To the Board of Water Commissioners of the Town of Franklin, MR. BRADLEY M. ROCKWOOD, *Chairman.*

GENTLEMEN: — The State Board of Health has considered your application for advice as to the construction of a large well near the system of tubular wells at the northwesterly end of Beaver Pond, now used as the source of water supply for the town, and has examined the available records of the operation of the present wells and the results of analyses of numerous samples of water collected therefrom.

When these wells were first used the water obtained from them was of very good quality, they yielded water freely and the quantity seemed likely to be sufficient for the requirements of the town, but difficulty has since arisen from the clogging of the strainers about the bottoms of the wells which interferes materially with their yield.

Recently a large well has been put in for temporary use near the tubular wells and by connecting the suction main with this well, and pumping the water of the tubular wells into it, it is practicable by continued pumping to obtain enough water for the supply of the town at the present time.

Some time after the use of the tubular wells was begun the analyses of the water indicated that the quality was deteriorating and that pollution was finding its way into them from some source in the direction of Mine Brook. This polluting matter was, however, being thoroughly purified in its passage through the ground before entering the wells, so that it has not affected the safety of the water for drinking.

Careful observations of the effect of this pollution upon the ground water near Mine Brook show that for a time it had a tendency to diminish, but in the recent very dry season it has shown a marked increase, especially in the past three months, indicating that the improvement in the condition of the water was only temporary and that it may increase decidedly in the future.

The character of the soil, as shown by the wells now in use and various test wells sunk in the region between Beaver Pond and Mine Brook, is quite coarse and porous in the neighborhood of Mine Brook, but becomes very much finer near Beaver Pond. In order to avoid danger of the serious pollution of the water coming from the direction of Mine Brook, it will be essential to locate the proposed new well as near as practicable to Beaver Pond and it will consequently be necessary to locate the well in the finer and less favorable material for obtaining a large yield of water.

The experience with the present well and the tubular wells indicates that, while with a permanent large well of considerable depth in this locality, it will probably be practicable to obtain enough water for the present needs of Franklin, the quantity to be obtained there is evidently limited by the necessity of avoiding the territory which yields water of poor quality, and under the circumstances it is desirable to select some other location where the conditions are more favorable for obtaining an adequate supply of water sufficient not only for present needs but to make reasonable allowance for the growth of the town and for an increase in the use of water, and if such a location can be found in the region near your present pumping station, the cost of a well in a more favorable place may be little, if any, greater than the cost of further development of the present sources. Moreover, if water can be found in large quantity at some new location in this region, the present sources can be retained for use in emergencies and will be valuable for such use.

In accordance with suggestions from this department tests have recently been made southwesterly from the pumping station near Beaver

Pond and a tributary of Mine Brook, which enters it from the west near Beaver Pond. Two test wells have recently been driven west of this brook, both of which penetrated a deep stratum of porous material from which water could be pumped very freely with a hand pump, and analyses of samples of water from these wells show one of them to be of very good quality for water supply purposes and the other to be of similar character, except that it contained a large amount of iron, which may have been due to the work of driving and taking the sample before the well was pumped clear. The location in question is apparently nearer the pumping station than the locality in which the present wells are situated, and if a sufficient quantity of water can be obtained here it would probably be practicable to supply it to the town from this source by means of the present pumping works.

In view of the favorable character of these tests and the fact that the test wells are nearer the pumping station than the wells from which the supply of the town is now obtained, it is not unlikely that a water supply for the town can be developed in the region southwesterly from the pumping station at a cost which would be little if any greater than the cost of necessary further development of your present sources.

Considering the circumstances the Board recommends that before taking action toward the construction of a permanent well near your present sources of supply you make a further test near the tributary of Mine Brook in the region where the recent test wells were driven in order to determine the depth and extent of the porous soil and the probable quantity of water that can be obtained there. For this purpose it will be necessary to put in a group of test wells and to pump from them for a period of ten days at least at a rate equal as nearly as practicable to the maximum rate at which water is used in the town. The Board will assist you in these investigations by making the necessary analyses of water and when further tests have been made will advise you as to the most appropriate source for the supply of the town.

Nov. 11, 1909.

To the Board of Water and Sewer Commissioners of the Town of Franklin, Mr. Bradley M. Rockwood, *Chairman.*

Gentlemen: — In response to your request of Nov. 9, 1909, the State Board of Health has examined the results of a pumping test made by pumping from a group of ten tubular wells located about 1,500 feet southwest of the pumping station of the Franklin water works, on the westerly side of a tributary of Mine Brook, near Beaver Pond, and has caused samples of water collected and sent in by you at intervals during the test to be analyzed.

The results of the analyses show that the water is of very good quality

for domestic purposes. Observations made while the test was in progress show that pumping was continued for a period of eight days at a rate ranging from about 625,000 gallons per day at the beginning of the test to about 860,000 gallons per day near its end. Observations of the height of water in the ground in this neighborhood show that the ground water level was not materially lowered during the latter portion of the test and indicate that a large quantity of water, probably ample for the requirements of Franklin, can be obtained from the ground in this region.

The Board approves the use of water from wells at this place for the supply of the town of Franklin, and recommends that works for supplying this water to the town be provided as soon as practicable.

Gardner.

Aug. 5, 1909.

To the Board of Water Commissioners of the Town of Gardner.

Gentlemen: — The State Board of Health received from you on July 31, 1909, through your engineer, Mr. George A. Kimball of Boston, an application for advice with reference to a proposed additional water supply for the town of Gardner, to be taken from Perley, or Kneeland, Brook, containing the following outline of your proposed plan: —

It is recommended that water for filling the lake gradually and then from time to time in the future, as may be needed, be taken from Kneeland or Perley Brook by building a low dam across the stream near to and just north of Clark street, from which water will be pumped to Crystal lake during the freshet season, viz., February, March and April. From preliminary studies I conclude that a pump with a capacity of 3,000,000 gallons in 24 hours will be sufficient. A rough estimate of the cost of the scheme recommended, excluding the cost of land, is $25,000.

A survey of the watershed of Kneeland Brook has been made, and a blue print of the same, dated April 15, 1909, is handed you herewith. The area of the watershed is 2.75 square miles. There are 12 houses on the watershed, with an estimated population of 72. The site of the proposed pumping station will be about 106 feet below Crystal Lake. The Water Board proposes to purchase considerable land and at least one farm and buildings on the watershed.

The surroundings of Crystal Lake have been improved, and I am informed that all but one of the dwellings near the lake have been connected with the sewer. The remaining dwelling is low down in a valley which is separated from the lake by a high ridge. The shores of the lake are kept clean, and the houses and yards on the watershed are carefully inspected. The portion of the lake lying southwest of the railroad has been cut off from the main lake by filling the railroad embankment solid with earth.

The Board has caused the proposed source of supply to be examined by its engineer and samples of the water to be analyzed and has considered the information presented as to the condition of Crystal Lake, the present source of supply.

The results of the recent examinations show that a material improvement has been made in the conditions affecting the purity of the water of Crystal Lake within the past two years. The smaller portion of the lake southwest of the railroad, which formerly received considerable pollution by drainage from a thickly settled area, has been separated from the main portion by an earth filling placed along the railroad embankment, and a channel has been provided so that the water draining into this small section of the lake finds an outlet into the stream below it. It also appears that all but one of the dwelling houses remaining on the watershed tributary to the lake are now connected with the sewers. The lake is still, however, exposed to pollution from the cemetery and from its use as a resort for boating and fishing, and, in the opinion of the Board, it is very desirable that, while its use as a source of water supply is continued, suitable rules and regulations for preventing its pollution be adopted and strictly enforced.

The consumption of water by the town has evidently been considerably in excess of the yield of the lake in dry periods for several years. It appears that a careful inspection of the water pipes and fixtures, made recently under your direction, has resulted in reducing very considerably the consumption of water by stopping leaks in the pipes and fixtures and by preventing waste; and, in consequence, the quantity of water pumped for the supply of the town at the present time is less than for several years and less than the estimated yield of the lake. Recent improvements have, however, reduced somewhat the area of the lake and its watershed, and, in addition to the quantity of water pumped for the supply of the town, water is drawn from the lake for use in a factory near by and for the supply of an auxiliary system of pipes which passes through the valley of the brook below the lake and is used chiefly in case of fire. The quantity of water used through this low-pressure system, so called, is said to be small, but it has not been measured; and, considering the circumstances, it is unlikely that the consumption of water has been reduced to such an extent that the lake will fill again until an additional supply has been provided. If efficient measures for preventing waste are continued the additional supply required is likely to be small for several years in the future.

The watershed of Perley Brook, the proposed source of supply, contains few inhabitants, and by acquiring a few of the farms within the watershed, the water could be protected from pollution without serious difficulty.

Analyses show that the water is usually highly colored and contains a large quantity of organic matter, but that at times of high flow in the winter and spring the color and quantity of organic matter present in the water are less than usual; and it is probable that by using the water only in the months when the flow is greatest — February, March and April — water can be introduced from Perley Brook into Crystal Lake without affecting seriously the quality of the water of the lake.

There appears to be no other practicable plan by which the water supply of the town can be increased, unless at a considerably greater expense; and, considering the circumstances, it appears to the Board that the plan proposed is a reasonable one to adopt. It is very important that the consumption of water in the town be kept within reasonable limits in future by restricting unnecessary use and waste, that the lake be filled gradually with water from Perley Brook, using the water when the color and quantity of organic matter present are smallest, and, finally, that rules for the sanitary protection of the lake and its watershed be secured and enforced.

By carrying out the proposed plan and the recommendations herein contained, the Board is of the opinion that a sufficient supply of good water can be provided for the use of the town of Gardner for several years in the future.

Gloucester (Wells).

Oct. 14, 1909.

To Hon. Henry H. Parsons, *Mayor of the City of Gloucester.*

Dear Sir: — Complaint has been made to this Board of the inadequacy of the water supply in the district adjacent to Folly Cove in the extreme northerly part of the city of Gloucester, which is not provided with a public water supply, and the Board has caused the locality to be examined and samples of water collected from four wells now in use in the village to be analyzed.

The results of the analyses show that the water from these wells is very badly polluted by sewage and contains an excessive quantity of organic matter. The number of bacteria present in the water of all of the wells was high and bacteria characteristic of sewage were found to be present in the water of all of the wells. In the opinion of the Board, the further use of water from any of these wells for domestic purposes is likely to cause sickness.

On account of the unusual dry season and from other causes many of the wells are dry or unfit to use and apparently the four wells examined are the chief sources of water supply of the district. The wells are in most cases shallow, and as there is no sewerage system, practically all of the sewage and foul matter from dwellings is discharged into vaults

and cesspools located at no great distance from the wells, and the pollution of these sources of water supply cannot be effectually prevented and is likely to increase.

In the opinion of the Board, it is essential for the proper protection of the public health in this village that a public water supply be introduced as soon as practicable and the further use of water from wells in this region discontinued. One of the mains of the Gloucester water supply system has been extended to within about half a mile of the boundary line between Gloucester and Rockport in this region and the laying of about half a mile of water pipe in Washington and Woodbury streets would make the public water supply of the city available to the inhabitants of this district. The Board recommends the city of Gloucester to extend its water pipes to this district as soon as practicable.

Grafton.

May 6, 1909.

To the Grafton Water Company, Grafton, Mass.

Gentlemen: — The State Board of Health received from you on April 3 through your consulting engineer an application for advice as to an additional water supply for Grafton, accompanied by plans of the proposed new works and information relative thereto, including samples of the soil from test wells in the neighborhood.

The plans provide for constructing a new well about 25 feet in diameter and 19 feet in depth, to be located on the ground now owned by the company on the easterly bank of the Quinsigamond River adjoining the northerly side of Millbury Street. The new well, according to the plan submitted, is to be located between the filter gallery and the Quinsigamond River, about 250 feet from the former and a little over 80 feet from the latter.

The Board has caused the locality to be examined by one of its engineers and has carefully examined the plans and information submitted therewith. The yield of the present filter gallery is much too small for the supply of the town in the drier portion of the year, and a deep tubular well, installed at the pumping station several years ago, appears to have furnished but little water. The filter gallery is located very close to the village and analyses of its waters show that the portion of the water entering it has been considerably polluted but subsequently well purified in its passage through the ground before entering the filter gallery, and analyses in recent years indicate that there has been an improvement in respect to the pollution of the water.

The location of the proposed new well is somewhat more favorable for obtaining water freely from the ground than that of the filter gallery,

and the test wells in this region penetrated strata of porous soil, a condition favorable to obtaining water freely from the ground.

It is impossible to advise you, however, with the limited amount of information thus far available whether the new well would yield enough water, in addition to the filter gallery, for the requirements of the town at all times, nor is it possible to predict definitely the probable quality of the water likely to be obtained therefrom.

The character of the soil in the region north of the proposed well, judging from surface indications, appears to be somewhat more favorable for obtaining water freely from the ground than at the point where the well is located, and if it is decided to put in the well without further tests, it would probably be best to change its location to a point 100 feet or more north of the location now selected and from 60 to 80 feet from the river.

There are other localities at no great distance from the present sources, where the conditions appear to be more favorable for obtaining water freely from the ground than at any point on the land owned by the company, and, in the opinion of the Board, it is advisable to make tests at these more favorable localities before beginning the construction of works for an additional supply. If it is impracticable to make tests at any of the more favorable locations outside of the company's grounds, the Board recommends that further test wells be put in in the neighborhood of the proposed new well, and if favorable conditions for obtaining water from the ground are found, that a group of wells be put in and that water be pumped from them for a period of several days to determine more definitely the probable quantity and quality of the water obtainable in that locality.

The Board will assist you in further investigations, should you decide to make them, by making the necessary analyses of water, and, upon application, will give you further advice in this matter when you have the results of further tests to present.

Grafton (Grafton Colony for the Insane).

Oct. 14, 1909.

To the Trustees of the Worcester Insane Asylum, E. V. Scribner, M.D., *Supertendent.*

Gentlemen: — The State Board of Health received from you on Oct. 1, 1909, an application for advice as to a proposed additional water supply for the use of the Grafton Colony for the Insane, to be taken from a system of driven wells located about half a mile southeast of Colony No. 1, and in response to this application the Board has caused the locality to be examined and samples of water collected from a group

of ten test wells in this locality during a pumping test in the latter part of September to be analyzed.

From the information furnished to the Board it appears that the wells are from 19 to 25 feet in depth and were driven through coarse sand into a stratum of gravel from two to three feet in thickness. During the pumping test, which was continued for a period of about ten days, from September 21 to October 1, water was drawn from the wells at a rate of a little less than 180,000 gallons per day. The water was not carried away to a sufficient distance from the wells to prevent the possibility of a portion of it returning to the ground before the end of the test, but nevertheless the results indicate quite clearly that a supply of water sufficient for the necessary requirements of the asylum can be obtained from the ground in this locality.

The results of analyses of samples of the water collected from time to time during the test show that it is of good quality for the purposes of a public water supply.

In the opinion of the Board the proposed source is an appropriate one from which to take water for the supply of the Grafton Colony.

Granville (Granville Center).

Oct. 14, 1909.

To Mr. J. M. Stevenson, *Pittsfield, Mass.*

Dear Sir: — In accordance with your request of Sept. 2, 1909, for an examination of the water of Downey's Springs, so called, and advice as to their use as a source of water supply for the village of Granville Center, the Board has caused the springs to be examined and a sample of the water to be analyzed.

The results of the analysis show that the water is of very good quality for all the purposes of a public water supply. No information is available as to the quantity of water which the springs are capable of yielding, but the population to be supplied does not, apparently, exceed 100 and a quantity of water amounting to 6,000 gallons per day would probably be sufficient for present needs. Judging from the area of the watershed above the springs, it should not be very difficult to obtain this quantity of water from this locality, but the Board recommends that before taking water from this source you cause observations to be made of the quantity of water flowing from the springs at the present time.

When these observations are available, the Board will advise you more definitely as to the use of these springs as a source of public water supply for the village.

HADLEY (HADLEY WATER SUPPLY DISTRICT).

OCT. 14, 1909.

To the Board of Water Commissioners of the Hadley Water Supply District, Hadley, Mass., MR. E. S. ALLEN, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on Sept. 7, 1909, an application requesting its approval, under the provisions of chapter 146 of the Acts of the year 1905, of the construction of an additional reservoir on Harts Brook, about 1,700 feet down-stream from the present reservoir and at a level 60 feet lower than that of the present source.

It appears that the supply of water furnished by the storage reservoir on Harts Brook has hitherto been sufficient for the supply of the town, but a large quantity of water is lost from the reservoir by leakage or filtration past the dam and the quantity of water in storage has been reduced to a small amount. The area of the district has recently been greatly enlarged and it is anticipated that, while the territory added does not contain a large population, there will be a considerable increase in the demand for water from the public works. The proposed additional reservoir is designed to meet the increasing requirements of the district, but it is understood that this reservoir will be used only when the supply available from the upper reservoir is inadequate.

The Board has caused the location of the proposed new reservoir to be examined by one of its engineers and has examined the plan and information submitted therewith. The increased area of watershed obtainable by the construction of the reservoir will apparently amount to less than 75 acres and the additional supply obtainable from this area would not be likely to increase very materially the quantity of water available for the use of the district. The new reservoir will be likely, however, to intercept much of the water lost from the present reservoir by leakage or filtration past the dam, and its yield is likely to be greater than the area of the watershed would indicate. It is impossible to determine, however, how much of an increase will be made in the water supply available for the district by the construction of this reservoir, but, in the opinion of the Board, it is unlikely that even if the dam of the new reservoir shall be made tight, the increase will be a very considerable one.

If the new reservoir should be used, the water pressure in the village would be at such times very considerably reduced, — the reduction amounting probably to as much as 25 pounds, — leaving about 60 pounds available for the distribution of the water. While this amount is probably sufficient under present conditions, a higher pressure may

be found very desirable in the future, and it is inadvisable, in the opinion of the Board, to reduce the pressure upon the mains unless necessary.

In 1906, in response to an application requesting the approval by the Board of the taking of certain additional sources of water supply, under the provisions of chapter 146 of the Acts of the year 1905, the Board, after a consideration of the circumstances, recommended that further observations be made as to the quantity of water used by the district and the yield of the present source, and that, if it were found that a large quantity of water was being lost by leakage, careful investigations should be made to determine the practicability of preventing the excessive waste of water in this way. The Board also stated that, when the results of these investigations were available, the Board would advise you as to the most appropriate method of enlarging your water supply, in case a larger supply should be found necessary.

It appears that the bottom of the reservoir has been treated for the reduction of the leakage and some of the leakage has apparently been prevented, but the quantity of water used by the district has not been determined, nor does it appear that careful studies have been made to determine whether a sufficient additional supply cannot be obtained from territory adjacent to the present source and at the same level.

The Board recommends that these investigations be made without delay, and when the results are available, if you will submit them, the Board will then determine the desirability of constructing the proposed new reservoir on Harts Brook.

Hopkinton.

Feb. 4, 1909.

To the Board of Water Commissioners of the Town of Hopkinton, Mr. George L. Hemenway, *Clerk.*

Gentlemen: — The State Board of Health has considered your application for advice as to a proposed additional water supply for the town of Hopkinton, in which you mention as possible sources of supply (1) a new well driven in the grounds about the pumping station in which the present wells are located, (2) Whitehall Pond, and (3) the Hopkinton reservoir of the Metropolitan Water Works system or ground water from its neighborhood, and has caused the sources mentioned and other possible sources of water supply in the neighborhood of the town to be examined by one of its engineers.

The water of your present source of supply, which is derived from four deep tubular wells on the hillside in the thickly populated part of the village, has greatly deteriorated in quality in the past year, and while in its present condition it is probably safe for drinking, it is

evidently composed largely of purified sewage and its use for drinking should be discontinued as soon as a water of better quality can be secured. It is evident, moreover, from the experience in many seasons, especially in that of 1908, that the quantity of water obtainable from the present sources is inadequate for the requirements of the village.

The first plan for an additional supply mentioned in the application, that of driving a well in the grounds now owned by the town, in which the present wells are located, would probably not increase materially the quantity of water obtainable from these sources and the quality of the water would doubtless be as objectionable as that of the present supply.

The water of Whitehall Pond is safe for drinking and is soft and in most respects of good quality for the purposes of a public water supply. It is affected at times, in common with most such sources, by growths of microscopic organisms, which impart to the water a disagreeable taste and odor, and while this source may reasonably be used, if necessary, it is desirable to secure a water of better quality. The Hopkinton reservoir of the Metropolitan Water Works system would furnish water of similar, though possibly somewhat better, quality than that of Whitehall Pond.

As to the practicability of obtaining a ground water supply in the neighborhood of Hopkinton reservoir, the Board is unable to give you definite advice at the present time, since the winter season is not a favorable one in which to make the necessary examinations of such sources. Such examinations as have been made in the neighborhood of Reservoir No. 6, however, indicate that a supply of water might be obtained from the ground on the northwesterly side of this reservoir at a point about two miles from the village. This reservoir is subject, however, to great fluctuation in level and the yield of a ground water supply taken from its neighborhood might be very much less when the reservoir is drawn low than at other times.

Of the other possible sources of supply the most favorable appears to be the ground in the northwesterly part of the town near the confluence of the brook flowing from Whitehall Pond and one of its tributaries, a little over a mile northwest of the village of Woodville. It is also possible that an adequate supply of ground water might be obtained from the valley of a tributary of Indian Brook in the neighborhood of the highway from Hopkinton to Upton, about a mile west of the village of Hopkinton.

As a result of the examinations thus far made, the Board advises the town to make investigations for a ground water supply at some of the more favorable localities within its limits. A good ground water supply will prove much more satisfactory than water from either Whitehall

Pond or the Hopkinton reservoir or the water of your present sources of supply, which is at times objectionably hard. Moreover, considering the pollution of the water of your present sources, it is very desirable that in selecting a new water supply a source be secured that will provide a sufficient quantity of water for all the requirements of the town, so that the use of the present sources may be discontinued. The Board recommends that you make tests with a view to obtaining a ground water supply at some of the more favorable localities within the limits of the town, and that in making the investigations suggested you secure the assistance of an engineer of experience in matters relating to ground water supplies. The Board will assist you by making the necessary analyses of water and will give you further advice when you have the results of further investigations to present.

DEC. 2, 1909.

To the Board of Health of the Town of Hopkinton.

GENTLEMEN: — In response to your request for advice as to the necessity of cleaning out the tank or standpipe used in conjunction with the water supply system of the town of Hopkinton, the Board has caused the works to be examined and a sample of the water from this reservoir to be analyzed.

At the time this examination was made the standpipe, which is 35 feet in diameter and 35 feet in height, contained about 13 or 14 feet of water, which was practically clear and colorless. An examination of the bottom indicates that there is a deposit there of about an inch of material consisting chiefly of sand and iron rust.

An analysis of a sample of the water from the standpipe shows that it contained at this time a slightly greater quantity of organic matter than the water drawn directly from the well, this slight deterioration being due probably to the exposure of the water to light in the standpipe, which is not covered. When ground waters, such as that drawn from wells at Hopkinton, are exposed freely to sunlight, they are usually affected by growths of microscopic organisms which often give the water a disagreeable taste and odor, and it is not unlikely that the taste and odor that have been noticed in the water supplied to Hopkinton have been due to this cause.

So far as the quality of the water is concerned it does not appear to the Board necessary to clean the standpipe at present, and considering the limited capacity of the present sources of supply, it is not desirable to empty the standpipe until a suitable additional supply has been provided. The shortage of water which has been severely felt in this town during dry weather, especially in the last two years, is a very objectionable con-

dition from a sanitary point of view, and an adequate supply of good water should be introduced as soon as possible, as recommended by the Board in a recent communication on this subject.

Huntington.

Jan. 7, 1909.

To the Board of Water Commissioners of the Town of Huntington.

Gentlemen: — The State Board of Health has considered your application for the approval, under the provisions of chapter 592 of the Acts of the year 1908, of the taking of water from the ground between the Boston & Albany Railroad and the west bank of the Westfield River about 400 feet above the mouth of Cold Brook, so called, your present source of water supply, and for its approval of the location of a group of tubular wells from which the supply of water for the town is to be drawn, and has caused the locality to be examined by its engineer and samples of the water to be analyzed.

The results of the examinations show that the water is of good quality for all purposes of a public water supply, and that the region about the wells is uninhabited and at the present time free from possible sources of pollution. The Board approves the taking of water from the ground at this place for the water supply of the town of Huntington, and approves the location of the nine wells now connected with the pump and ready for use.

Lanesborough.

March 4, 1909.

To the Board of Health of the Town of Lanesborough.

Gentlemen: — The State Board of Health has considered your application for advice as to certain proposed sources of water supply for the town of Lanesborough described in a report prepared by engineers employed by the town several years ago and submitted with your application, and has caused the sources of supply mentioned in the report to be examined by one of its engineers and samples of their waters to be analyzed.

The waters of all of the sources mentioned — Rice Brook, Newton Brook, and the Housatonic River, also known as Town Brook — are quite hard but in other respects are naturally of good quality for water supply purposes. Rice Brook above the point at which that stream would furnish water to the villages of Lanesborough by gravity under adequate pressure has so small a drainage area that it would be necessary to construct a storage reservoir of considerable size in order to secure from that stream a sufficient quantity of water for the requirements of the town at all times. It is not practicable at this season of the year to make a suffi-

ciently thorough examination to determine whether a reservoir of adequate size for the purpose could be constructed on that brook. While the water of the stream is naturally of good quality for water supply purposes, there are two groups of farm buildings within its watershed, both of which are located near the brook, and if that stream should be taken as a source of water supply for the town it would probably be necessary, in order to protect the purity of the supply, to acquire all of these buildings, thus adding considerably to the cost of a water supply from that source.

The watershed of Newton Brook above the point at which it is proposed to take the water is uninhabited, and the water, though harder than is desirable, is of good quality for water supply purposes. It is likely that a sufficient supply of water for the requirements of the villages could be obtained from this brook with the aid of a small storage reservoir, and while it has not been practicable to examine the locality carefully it is probable that a reservoir of sufficient size could be constructed upon the stream without serious difficulty.

It is suggested that water drawn from this brook might be stored in a reservoir constructed at some point near the village, but it is unlikely that there will be any advantage in such a plan, and it would be better, in the opinion of the Board, to construct the reservoir on the stream itself if practicable.

The third source mentioned is the Housatonic River, or "Town Brook," so called, at some point north of the village of Lanesborough, from which it is proposed to pump the water to a reservoir on the hill northeast of the village and thence supply it to the town. The water of the Housatonic River is naturally of good quality for water supply purposes and there is no doubt that a sufficient supply could be obtained from the stream in question, but this stream drains a large area containing numerous dwelling houses and groups of farm buildings, and, in the opinion of the Board, cannot be regarded as a safe source from which to take water directly for drinking.

As a result of the investigations thus far made it appears to the Board that Newton Brook is likely to be the most desirable of the sources mentioned in your application. It is not practicable at this season of the year to make a sufficiently thorough investigation of the sources which appear to be available for the use of the town to determine which one is likely to be the most appropriate for the purpose. It is understood that it is proposed to supply water to the village of Berkshire as well as to Lanesborough, and in that case it may be practicable to obtain a supply of water of excellent quality from some of the streams tributary to the Cheshire Reservoir, especially on its easterly side, at less expense

than from any of the sources mentioned in your application. It may also be practicable to obtain a supply of water from tubular wells in the neighborhood of Lanesborough or in the vicinity of Berkshire at less expense than from any of the available streams.

The Board recommends that you cause further investigations to be made of all of the available sources of water supply in and about the town, and that tests be made to determine the practicability of obtaining a water supply from the ground if conditions favorable for obtaining a supply in that way appear to exist at any place within a reasonable distance of either of the principal villages of the town. The Board will assist you, if you so request, by making further examinations of the streams in the neighborhood of the town and by analyzing the water of any test wells or other proposed sources, and will give you further advice in the matter when you have the results of further investigations to present. The Board recommends that the investigations be made in the summer season when the conditions are favorable for such work, and that you secure the assistance of an engineer of experience in such matters.

Leicester (Cherry Valley and Rochdale).

May 6, 1909.

To the Water Supply Committee of Cherry Valley and Rochdale in the Town of Leicester.

Gentlemen: — The State Board of Health received from you on April 2, 1909, an application for advice as to a water supply for the villages of Cherry Valley and Rochdale in the town of Leicester, to be taken from a well near Henshaw Pond located between the two villages.

The Board has caused the locality to be examined by one of its engineers and has examined the information presented as to the proposed source of supply and the results of analyses of samples of water collected from a test well located near the point at which it proposed to construct a large well for the supply of the villages. Very little water had been pumped from the well before the samples were collected, and the water was quite turbid and contained a considerable amount of suspended matter, but the results of the analyses indicate that water of good quality may be obtained from the ground at this location.

Regarding the quantity of water obtainable from the proposed source, it is impracticable to give a definite estimate from the tests thus far made. The test well penetrated a coarse stratum which yielded water quite freely, indicating that a large quantity of water might be obtained from the ground by a suitable well in this locality.

The Board recommends that before deciding upon this source for the supply of the districts in question, you cause a further test to be made

by sinking the well to a greater depth and pumping from it continuously for a period of about two weeks. During this test samples of the water should be collected for analysis, and when the results of the tests are available the Board will give you further advice as to the practicability of obtaining an adequate supply of good water by the plan now proposed.

Nov. 26, 1909.

To the Cherry Valley-Rochdale Water District Committee, Leicester, Mass.

GENTLEMEN: — The State Board of Health has considered your application for advice as to the use of water from a well near Henshaw Pond in Leicester for the supply of the villages of Cherry Valley and Rochdale, which it is proposed to incorporate into a water supply district, and has examined the results of analyses of samples of water collected from a test well near Henshaw Pond during a pumping test between Sept. 24 and Oct. 1, 1909.

The analyses indicate that water taken from the ground in this locality is likely to be of good quality for domestic purposes.

It appears from the information furnished by you that the test well was 12 feet long, 5 feet wide and about 15½ feet deep, and that it was excavated to ledge, the soil encountered consisting of fairly coarse gravel, containing numerous boulders of all sizes, the gravel becoming coarser toward the bottom of the well. The quantity of water pumped from the well amounted to an average of 65,000 gallons per day during a period of about 10 days. The character of the soil about the well does not appear to be very favorable for obtaining a large yield of water from the ground, and it is probable that much of the water which might be obtained from a well in the locality in which this test was made would be derived by filtration from Henshaw Pond. This pond has an area of about 43 acres and a drainage area of about .85 of a square mile. The watershed is sparsely populated and contains very few dwelling houses, practically all of which are located in the village of Leicester at its extreme upper end. The water is not highly colored, and, under the circumstances, water which might find its way from the pond through the ground and into the well is likely to be unobjectionable. It is probable that the quantity of water obtainable from the ground in this locality could be increased by putting in additional wells and if in very dry seasons the yield of the wells should prove insufficient an additional supply might be obtained by filtering the water of the pond. It is probable that an open filter of inexpensive construction would be sufficient for the purification of any water which it is likely to be necessary to take from that source.

Considering the circumstances, the plan of taking water from wells

near Henshaw Pond for the supply of the villages of Cherry Valley and Rochdale appears to be a reasonable one to adopt, but it is important that care should be taken in the construction and operation of the works to prevent loss of water by waste or by leakage from the pipes.

Lincoln.

June 3, 1909.

To the Board of Water Commissioners of the Town of Lincoln, Mr. George L. Chapin, *Chairman.*

Gentlemen: — The State Board of Health received from you on April 22, 1909, the following communication relative to the use of Sandy Pond in Lincoln as a source of water supply for the towns of Lincoln and Concord: —

The Water Board of the Town of Lincoln respectfully asks the advice of the State Board of Health concerning the further joint use of Sandy Pond by the towns of Lincoln and Concord. Since the request of Jan. 29, 1906, and the letter of the Board of Health dated April 5, 1906, the undersigned have had the problem carefully examined, new data not known at that time have been discovered, and we think that upon a re-examination of the matter the Board will conclude that the further joint use of the pond is inadvisable.

The undersigned also request the privilege of submitting the information collected by them in detail to your Honorable Board.

This question was considered by the Board in response to a request from the town of Lincoln in 1906, and the Board advised that it was not essential that the use of water from the pond be immediately restricted but that means be provided as soon as practicable for measuring with reasonable accuracy all the water drawn or discharged from Sandy Pond, and that observations be made of the height of water, so that its yield and capacity could be determined and the use of water from the pond restricted to the amount that it is capable of supplying continuously.

The Board has in response to your request caused a further examination of the pond to be made and has examined the available records of the quantity of water used by the towns of Concord and Lincoln and the height of water in the pond.

The level of the water in the pond at the time of the previous reply of the board was 3 feet below full pond. During the dry season of 1908 it fell nearly to a level of 7 feet below full pond, and the rainfall of the present year, though considerably greater than the average up to the present time, has raised the level of the water only to a point about 5 feet below high water.

It is evident that the present rate of use of water from this pond is

greater than the amount it is capable of supplying in a long series of years, and if its use is to continue at the present rate the quantity of water in the pond will diminish until it becomes practically exhausted.

A new survey of the pond during the past year shows that there is a considerable area near the Lincoln intake over which the depth of water is only about 12 feet at full pond. The bottom of this area is covered deeply with mud and there appears to be much danger that, unless the level of the pond is allowed to rise, vegetation will grow in this shallow area. Moreover, vegetation is springing up on the exposed shores of the pond, which have now been uncovered for several years. For these reasons a continuation of the conditions of the past months is likely to have an unfavorable effect on the quality of the water, and, in the opinion of the Board, the use of water should be diminished to a quantity which will allow the pond to fill in years of ordinary rainfall.

Since January, 1908, the quantity of water used in the town of Concord has been measured through a Venturi meter. In Lincoln a Venturi meter has also recently been installed to measure more definitely than it was practicable by the pumping records the quantity of water used. The records are not very satisfactory but the results of the available measurements indicate that the quantity of water used in both towns is very large, and it is probable, in the opinion of the Board, that the draft of water from the pond could be very materially reduced, possibly by the stoppage of leakage from the main pipes or by the use of meters on all service pipes.

Calculations show that the pond is probably capable of yielding in the neighborhood of 600,000 gallons per day, and the Board advises that the use of water from the pond be restricted to that quantity until the pond has filled again. The Board is informed that the town of Concord has already taken steps to secure an additional supply of water from another source, so that it will apparently soon be practicable to restrict the use of water to a quantity well within the amount indicated.

LYNN (SPRINGS). AUG. 5, 1909.

To the Board of Health of the City of Lynn, MR. GUSTAVUS A. BADGER, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on June 21, 1909, the following application for an examination of the water of certain springs in the city of Lynn:

The Board of Health of Lynn most respectfully asks you to analyze the water from the following springs which is used for drinking purposes in this city; Moose Hill Spring, Electric Spring, Sterling Street Spring, Lover's Leap Spring, Graham's Spring, Twin Spring, Bassett's Spring and Greenleaf Spring.

Moose Hill Spring is located near the Swampscott Station of the Boston and Maine Railroad in a densely populated neighborhood. The water of this spring is very badly polluted from the population in its vicinity, but when the spring was examined the water was being filtered through a sand filter and the effluent was well purified. It is an objectionable drinking water on account of its great hardness, and its use should be discontinued.

Bassett's Spring is also located in Swampscott about 500 feet north of Moose Hill Spring and is situated in a densely populated district. At this place a filter has been introduced but was not in use at the time the examination was made, and the water was being supplied to the consumers directly from the spring.

An analysis of this water shows it to be very badly polluted and unfit for drinking.

Greenleaf Spring is located in Swampscott about 1,000 feet northeast of Bassett's Spring close to a densely populated neighborhood. The water has evidently been very badly polluted and, in the opinion of the Board, is unfit for drinking.

The Electric Spring, controlled by the Deep Glen Rock Spring Company, so called, is located near the junction of Greenwood Avenue and Linwood Street in the northwesterly part of Lynn. The examinations of its water which have been made from time to time show no material change in its quality, and in its present state the water of this spring is probably safe for drinking.

The Lover's Leap Spring, so called, is not now in use, but a well has been driven about 40 feet from the spring and 30 feet from Forest Street to a depth of 157 feet, mostly through rock, and water from this well is now being used for the manufacture of tonics, etc.

An analysis of the water of this well, which is under the same management as the Electric Spring, shows that it has been badly polluted though subsequently quite well purified in passing through the ground before entering the well, but it is extremely hard. In the opinion of the Board, it is an unsafe source from which to take water for drinking or for the purposes for which it is now used, and its use should be discontinued.

Graham Spring, near Walnut Street, in the westerly part of Lynn, derives its water from an uninhabited watershed. Analysis shows some deterioration in quality since the previous examination, but there appears to be no objection to its continued use as a source of drinking water supply.

Sterling Street Spring is located half a mile west of the Graham Spring and near Birch Pond. There are sources of pollution in its

neighborhood, but the quality of the water has not changed materially from its condition at the time of the previous examination, and in its present state the water of this spring can probably be used with safety.

Twin Spring is located near the junction of Hesper and Spring streets in Saugus about 500 feet from the Saugus River. The analysis of the water shows some evidence of previous pollution, and the quantity of organic matter present is higher than is found in good spring waters. There is evidently a growth of organisms in the basin in which the water is exposed to light. The water is probably safe for drinking, but its quality might be considerably improved by covering the basin in which it is collected.

SEPT. 2, 1909.

To the Board of Health of the City of Lynn, Mr. GUSTAVUS A. BADGER, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on Aug. 12, 1909, the following application requesting an examination of the water of certain springs in the city of Lynn: —

The Board of Health of the city of Lynn most respectfully asks you to analyze the water from the Peerless Spring used by M. C. Heald of this city, the Pocahontas Spring and the Sagamore Spring. The Peerless and Pocahontas Spring waters are used for drinking purposes in this city, and the proprietors of the Sagamore Spring, which is in Lynnfield Center, are desirous of bringing this water into Lynn for drinking purposes.

The water of Peerless Spring, so called, is derived from a driven well 2½ inches in diameter and said to be about 80 feet in depth, located a short distance from the corner of South Common and Commercial Street in Lynn and in a thickly populated district.

An analysis of the water shows that the water is hard and has at some time been very badly polluted but subsequently quite well purified in its passage through the ground before entering the well. In its present condition the water of this spring is probably safe for drinking, but there are sources of pollution at no great distance and the water may at any time deteriorate in quality and become unsafe for drinking. The Board recommends that its use for that purpose be prevented.

Pocahontas Spring is located in Lynnfield and has been examined on several previous occasions, the results showing that the water is of good quality for drinking. There are at present no buildings or other possible sources of pollution on the watershed of the spring which would be likely to affect the quality of its water, and in the opinion of the Board the water of this spring under present conditions may safely be used for drinking.

Sagamore Spring is located in Lynnfield about half a mile north of the Pocahontas Spring. The water is collected in a large uncovered basin and there are no sources of pollution in its neighborhood at the present time. The results of analyses show that the water is very soft and of good quality for drinking. It would be desirable, as a further protection to this source, to cover the basin in which the water is collected.

Manchester.

Jan. 7, 1909.

To the Board of Water Commissioners of the Town of Manchester.

Gentlemen: — The State Board of Health received from you on September 4 a petition for the approval by this Board of the taking of the waters of Gravel Pond and Round Pond and the waters which flow into and from the same, and certain lots of lands and rights of way in the towns of Manchester and Hamilton, for the purpose of holding, storing, purifying and preserving said waters, the location of said lands and rights of way being shown on a map submitted with your application, and in response to this petition has caused the locality to be examined by its engineer and has examined the plan presented.

Of the lands which it is proposed to take, two lots, numbered on the plan "Parcels 1 and 2," are located 800 feet or more north of the junction of Pleasant and Pine streets in Manchester and are to be used for the purpose of constructing a new distributing reservoir for your water supply system. Parcel No. 3, situated at the southerly end of Gravel Pond and including .55 of an acre, is to be used for the location of a pumping station and appears to be suitable and necessary for that purpose. Parcel No. 4 is located in part between Gravel and Round ponds and in part along the northwesterly side of Round Pond, and includes the brook flowing between the ponds, the outlets of Round Pond and certain gravelly areas containing soil suitable for the purification of water. The rights of way which it is proposed to take are chiefly existing private roadways, which are necessary to give access to the ponds and lands which the town proposes to take.

The Board has already advised, in a communication dated Dec. 5, 1907, that in its opinion the use of water from Gravel Pond, supplemented by Round Pond, is the best practicable method of increasing the water supply of Manchester, and, having considered the plans now presented, hereby approves the taking of the waters of Gravel Pond and Round Pond and the waters which flow into and from the same in the towns of Hamilton and Manchester, and approves also the taking of the lots of land and rights of way shown on said plan, which is entitled "Plan of lands, waters and water rights for an additional supply of water

for the town of Manchester, dated August 1st, 1908, Raymond C. Allen, Civil Engineer."

A description of the lands with rights of way, the taking of which is hereby approved, is appended.

Medfield (Medfield Insane Asylum).

Nov. 4, 1909.

To the Board of Trustees of the Medfield Insane Asylum.

Gentlemen: — On Nov. 6, 1908, the State Board of Health received from you a communication requesting its approval of a plan submitted by your engineer for supplementing the water supply of the Medfield Insane Asylum by taking water directly from Charles River, filtering it by means of a mechanical filter and supplying it for use in the laundry and stock barn, where the quantity of water used has been found to amount at times to as much as 70,000 gallons per day. Subsequently tests were made under your direction at various places for the purpose of determining the practicability of obtaining a ground water supply suitable for the requirements of the institution, and more recently a pumping test has been made by pumping from a group of tubular wells located on the easterly side of the river near your present pumping station, and the records of this test, together with samples of water, have been sent to the Board for examination.

The tests appear to show that the soil along the easterly bank of the river in the neighborhood of the hospital is for the most part very fine and yields but little water, but for a limited distance in the immediate neighborhood of the pumping station, close to the boundary between Dover and Medfield, it was quite porous and water could be drawn from it quite freely.

The information furnished as to the pumping test which was made in the latter part of September shows that water was pumped from the wells almost continuously for a period of about one week at a rate of somewhat more than 270,000 gallons per day, — six wells being used on the first day of the test, and four during the remainder of the period. The results indicate that a large additional supply of water for the use of the institution can be obtained from the ground in this locality, possibly enough for the entire supply of the asylum during a large part of the year.

The analyses of the water collected and sent in by you at frequent intervals during the test show the presence of a greater quantity of chlorine than the normal for this region, and a much higher quantity of nitrates than is found in good ground waters, indicating that a part at least of the water entering the wells has been polluted, though the

analyses indicate that this water, at the time of the test, was quite thoroughly purified in its passage through the ground before entering the wells. The cause of this condition has not been definitely ascertained, but there is a cesspool used for the disposal of the sewage of the employees at the power station, about 600 feet south of the wells, which may be the cause of the pollution of the ground water in this neighborhood.

While the water of the test wells, as shown by analyses of the samples sent in during the pumping test, would be safe for drinking, it is impracticable to tell from so short a test whether the quality would improve or deteriorate with continued use. It is likely, however, in the opinion of the Board, that if the sewage of the power station should be removed and the further pollution of the ground water in this locality prevented, the quality of the water would improve. The wells are so located that it would be practicable to take water from them for the supply of the institution at a very small expense, and if necessary this water could be used for laundry, mechanical and other purposes, retaining the water of Farm Pond for use for drinking and other purposes where an unpolluted water is essential.

Considering the circumstances, the Board advises that, after the removal of the cesspool and other possible sources of pollution of the ground water in the neighborhood of the wells, provision be made for using the water from them for the supply of the institution, and that its quality be carefully observed at frequent intervals by means of chemical analyses, so that in case serious deterioration occurs its use for drinking and cooking may be discontinued.

If it is decided to introduce this water for the supply of the institution, or for laundry, mechanical or other purposes therein, the Board will, upon request, make the necessary analyses from time to time to ascertain what changes take place in its quality.

Millbury.

Oct. 14, 1909.

To the Millbury Water Company, Millbury, Mass.

Gentlemen: — The State Board of Health received from you on Oct. 8, 1909, an application for advice as to the use of water from Singletary Pond, to be taken from the stream which flows from the pond at a point from 500 to 1,000 feet below its outlet, as an auxiliary supply for the town of Millbury, the yield of the well from which the town is ordinarily supplied being insufficient for its requirements at the present time; and in response to this application the Board has caused the pond and its surroundings to be examined and a sample of the water to be analyzed.

The water of Singletary Pond has but little color and in its present condition is of good quality for water supply purposes. An examination of the shores of the pond and the region about it shows that the population on the watershed is small, and that, excepting a few camps along the shores of the pond, which are occupied only in summer, the dwelling houses are situated for the most part near the outer limits of the watershed and remote from the pond and its feeders.

At the outlet of the pond, however, there are a dwelling house and group of out-buildings located close to the channel of Singletary Brook, which in this section is covered, and it is possible that the brook is polluted by drainage from these buildings. In view of these conditions, the Board recommends that water be taken directly from some point in the pond itself and not from the brook.

It appears that the shores of the pond are very shallow at most places about its southerly end and that the best practicable place from which to take water in the present emergency is in the immediate neighborhood of the outlet. At this point there is a boat landing, at which a number of boats are kept, but it is probable that by locating the intake in the lake beyond this landing, and by proper inspection, it will be practicable to prevent pollution of the pond for the next few months, but an intake in this locality should be discontinued permanently before the coming of another summer. The quantity of water required to meet the present emergency is not likely to be large, and efficient inspection can be provided without serious difficulty.

The Board is of the opinion that Singletary Pond is the best available source from which to obtain an additional supply of water for the town of Millbury to meet the present emergency, and that if the suggestions herein contained are carefully followed the water taken from the pond may safely be used for drinking and domestic purposes until the yield of the well shall again become sufficient to meet all requirements.

It is evident, from the experience of the present and of a previous year, that the quantity of water which the well now used for the supply of Millbury will yield is insufficient for the requirements of the town at all times, and the Board recommends that you take steps without delay to secure an additional supply of water of good quality sufficient with the present source for the requirements of the town at all times.

NORTH READING (MARTIN'S BROOK SANATORIUM).

MAY 13, 1909.

To the Commission on Hospitals for Consumptives, JOHN B. HAWES, 2d, M.D., *Secretary, 3 Joy Street, Boston, Mass.*

GENTLEMEN: — The State Board of Health received from you through your engineer on April 9, 1909, the following application for advice as to a proposed source of water supply for the Martin's Brook Sanatorium in the town of North Reading: —

In behalf of the Commission on Hospitals for Consumptives I would respectfully ask your advice relative to a proposed source of water supply for the hospital at North Reading.

It is proposed to obtain water from the hard ground bordering the Martin's Brook Meadows south of the institution. The tests which have been made indicate that all of the soil in this vicinity consists of sand, but in general the sand is so fine that it is impossible to separate the water from the sand. In one location, however, there is a vein of coarse sand about 25 feet beneath the surface of the ground and just above the ledge from which water can be drawn with great freedom. The vein of coarse material is of limited extent, but is sufficient for five or six wells, and we believe that it will yield enough water for the requirements of the institution.

The analyses of samples of water which have been collected from these test wells indicate that the water is of satisfactory quality. There are enough wells already driven to supply the required quantity of water in the beginning at least, and it is proposed to connect these wells and install the permanent pumping plant without making a preliminary pumping test in view of the fact that this installation will cost very little more than would be required for the pumping test, and the pumping plant can be moved at a comparatively small expense, should the water be found on continual pumping insufficient in quantity or of unsuitable quality.

The Board has caused the locality to be examined by one of its engineers and has considered the results of the tests thus far made in the southwesterly part of the hospital grounds. The results of the analyses of water from various test wells in this locality indicate that the ground water is naturally of good quality for water supply purposes, and it is probable that, if the wells are located 75 feet or more from the edge of the meadow, the quality of the water will not deteriorate with use.

Regarding the quantity of water obtainable from the ground in this locality, it is impracticable to give a definite estimate with the information thus far available. It appears that the soil encountered in driving the test wells in this region was in some places very fine but that in the locality in question there is a vein of coarse sand about 25 feet beneath

the surface and lying just above the ledge, from which water can be drawn very freely. The depth and extent of this porous material is not known, but the soil of the upland about the wells appears to be composed of coarse material, and conditions on the whole appear to be favorable for obtaining enough water at the locality indicated for the requirements of the institution.

In order to determine definitely whether enough water of good quality for the requirements of the institution can be obtained from wells in the location proposed, it will be necessary to make a further test by pumping from the wells continuously for a period of from one to two weeks, and the board recommends that such a test be made before the final works are installed.

The Board sees no objection, however, to carrying out the plan suggested by your engineer and obtaining machinery for this test, which can subsequently be used either here or in some other location, if a change shall become necessary. When you are ready to begin the test, the Board will, upon application, make the necessary analyses of the water and will give you further advice when the results of the test are available.

In case it shall finally be decided to take water from the locality now proposed, it will be necessary to construct the sewers which convey the sewage from the buildings to the sewage filtration area in such a manner as to prevent danger that leakage from them may pollute the wells.

Palmer (Boston Duck Company).

To the Boston Duck Company, Bondsville, Mass. July 1, 1909.

Gentlemen: — The State Board of Health received from you on June 1, 1909, through your engineer, the following application for advice as to the water now supplied by you to the village of Bondsville: —

In behalf of the Boston Duck Company of Bondsville, Mass., I would request your advice with reference to the water now supplied to the village of Bondsville by the company. In November, 1908, you advised that the examinations which had been made up to that time by means of test wells indicated that a supply of good water could be obtained from the locality being investigated, sufficient for all reasonable requirements in the mills and tenement houses.

Upon the strength of this advice, works have been put in for supplying the village from this source, and water has been pumped from the wells for a period of several months. The company now wishes to be assured that the water supplied by them to the village is of satisfactory quality.

In response to this request the Board has caused the wells and their surroundings to be examined by one of its engineers and samples of the water to be analyzed.

The results of the analyses show that the water is of very good quality for all the purposes of a public water supply.

The supply is obtained from a group of six tubular wells in the valley of Jabish Brook, and no definite information is available as to the quantity of water obtained from them. It is evident, however, that the yield is ample for present requirements, and a larger supply can doubtless be obtained if necessary in the future by increasing the number of wells and extending them over a wider area in this valley.

In the opinion of the Board this source is an appropriate one for the supply of the village of Bondsville.

Palmer (Well of Thorndike Company).

April 1, 1909.

To the Board of Health of the Town of Palmer, Mr. F. N. Carpenter, *Clerk.*

Gentlemen: — In response to your request of Nov. 30, 1908, for an examination of the water of a well of the Thorndike Company and advice as to the use of the water therefrom for the supply of the tenements and mills of the company in the village of Thorndike, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed.

The well in question was driven for ten feet through gravel or sand and for a further distance of about 700 feet in rock, and has only recently been completed. Most of the water entering the well is thought to be derived from a seam in the rock at a depth of about 300 feet from the surface. The well is located close to the mill and not far from the river — a location not very favorable for obtaining good water.

The results of the analysis indicate, however, that the water is at present of good quality for water supply purposes, but the quantity of water that can be obtained from the well is evidently much too small to supply the quantity required for domestic uses in the tenements and for drinking and other purposes in the mills of the company.

While this water might be sufficient to supplement other water now used in the tenements, the Board has found it unsafe to have two water supplies, one of which is unsuitable for drinking, running in the same house, and the Board recommends that further investigations be made with a view to securing an adequate supply of water for all the requirements of the dwelling houses and factory buildings for domestic and other purposes. Wells driven in rock in this state have rarely been found to yield any considerable quantity of water, and the Board recommends seeking a further source at some place in the neighborhood of the village where porous soil is found. The Board will assist in further investigations by making the necessary analyses of water and will give you further advice in the matter when the results of further tests are available.

Peabody.

Nov. 11, 1909.

To the Finance Committee of the Town of Peabody, Mr. William Armstrong, *Chairman.*

Gentlemen: — The State Board of Health received from you on Nov. 3, 1909, a petition for the consent and approval of this Board to the taking by purchase or otherwise of certain lands within the watershed of Spring Pond in the town of Peabody, and the cities of Lynn and Salem, for the purpose of protecting and preserving the purity of the water of said pond, which is used as a source of water supply for the town of Peabody, accompanied by a plan and a description of said lands.

In response to this petition the Board gave a hearing at its office, Room 143, State House, on Thursday, Nov. 11, 1909, after publishing notice of said hearing in the "Lynn Evening News," the "Lynn Evening Item" and the "Salem Evening News."

After the hearing, at which no one appeared to oppose the taking of the lands in question by said town, and after an examination of the lands proposed to be taken as described in your petition, the Board, upon consideration, voted to consent to and approve the taking by the town of Peabody of certain lands now or formerly of the Boston Interurban Realty Trust located easterly and southerly of Spring Pond and within the watershed thereof, amounting to 109.5 acres, more or less, shown on the plan presented with your petition, entitled "Peabody Water Works. Plan showing Land Takings at Spring Pond. Scale 1 inch = 200 feet. October, 1909. F. A. Barbour, Engineer."

The lands, the taking of which is herein approved, are comprised in four parcels, which are bounded, measured and described as follows: —

A certain parcel of land located in the City of Lynn upon the shore of Spring Pond, shown upon plan entitled "Peabody Water Works. Plan showing land takings at Spring Pond, scale 1 inch = 200 feet, dated October, 1909, F. A. Barbour, Engineer," and marked "A," said land being bounded and described as follows: —

Beginning at a stone bound on the shore of Spring Pond, marking the intersection of the boundary lines between the Town of Peabody and the cities of Lynn and Salem; thence N. 60° W ± along the boundary line between Peabody and Lynn, about 125 feet, to a stone wall; thence S. 21° W ± along said wall about 335 feet; thence S. 12° W ± along said wall about 165 feet; thence S. 6° E ± along said wall about 100 feet to the edge of the swamp; thence N. 45° E ± in a straight line about 60 feet to Spring Pond; thence along Spring Pond in a northerly direction about 520 feet to the point of beginning.

Also another parcel of land shown upon the aforesaid plan and marked "B," located partially in Salem and partially in Lynn, being bounded and described as follows: —

Beginning at point at the end of a stone wall on the shore of Spring Pond located about 435 feet northerly from a stone bound on the boundary line between Lynn and Salem; thence N. 63° E ± along said wall, about 120 feet, to an angle; thence S. 10° W ± about 255 feet; thence S. 29° W ± 285 feet; thence S. 67½° W. ± about 115 feet; thence N. 87½° W. ± about 160 feet; thence N. 60° W. ± about 295 feet; thence S. 48½ W. ± about 140 feet; thence N. 37° W. ± about 415 feet; thence S. 53½° W. ± about 750 feet to a stone wall; thence N. 2° W. ± along said wall about 100 feet; thence N. 11° W. ± along said wall about 70 feet; thence N. 39° W. ± along said wall about 30 feet to the edge of a swamp; thence N. 30½° E ± in a straight line about 50 feet to Spring Pond; thence along Spring Pond in a northerly and easterly direction to the point of beginning.

Also a triangular parcel of land, located adjacent to the above described parcel in Salem, marked "C" on the aforesaid plan, bounded and described as follows: —

Beginning at the end of the stone wall on the shore of Spring Pond, about 435 feet northerly from the boundary line between Lynn and Salem, being the point first described in the above description of lot "B"; thence N. 63° E ± along said wall about 1520 feet to another stone wall; thence N. 59° W ± about 1400 feet along said wall to Spring Pond; thence along Spring Pond in a southerly direction, about 1450 feet, to the point of beginning.

Also the right, title and interest of said Boston Interurban Realty Trust in a parcel of land marked "D" on said plan adjacent to the above described parcel, being about one undivided third of said parcel. Said parcel of land marked "D" being bounded and described as follows: —

Beginning at a point on the shore of Spring Pond in the wall between parcel "C" and "D", thence S. 59° E ± about 1400 feet along said wall to another wall; thence N. 63° E ± along said wall about 830 feet to a wall; thence in a general course of about N. 29° W along said wall 3200 feet ± to the "Reservoir" so called of the Town of Peabody; thence along said Reservoir about 275 feet to a stone wall and land of Town of Peabody; thence along said wall and land of Town of Peabody S. 20° W ± about 1340 feet to Spring Pond; thence along Spring Pond in an easterly and southerly direction to the point of beginning.

Pittsfield.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on Nov. 11, 1909, for preventing the pollution and securing the sanitary protection of the waters of Onota Lake and its tributaries, used by the city of Pittsfield as a source of water supply.

Oct. 14, 1909.

To the Board of Public Works of the City of Pittsfield.

Gentlemen: — The State Board of Health received from you on Sept. 17, 1909, an application requesting the approval by the Board of the taking of water from Onota Lake as a temporary water supply for the city of Pittsfield, under the provisions of chapter 25, section 35, of the Revised Laws, and in response to this application has caused a further examination to be made of the lake and its surroundings.

In response to a similar application made last year, the Board approved the use of Onota Lake as a temporary source of water supply for the city of Pittsfield, but suggested that the water be drawn from the southerly part of the lake instead of the northerly end, as then proposed. The plan now proposed provides for taking water from the cove close to the southerly end of the lake.

An examination of the locality shows that there is a large number of laborers engaged in construction work within the watershed of the lake not far from the proposed intake, and it is not advisable, under the circumstances, to take water from the small bay at the southeasterly end of the lake. It is apparently practicable to extend the intake pipe farther along West Street and take water from the southwesterly end of the lake, where there are no sources of pollution in its immediate neighborhood, and a suitable place from which to take water can be found on the easterly shore of the lake half a mile north of the location proposed. It is desirable in any case if water is taken from this lake that the possible sources of pollution within its watershed be inspected and danger of the contamination of the lake prevented while the use of its water is continued.

With these suggestions, the Board approves the taking of water from Onota Lake as a temporary water supply for the city of Pittsfield, under the provisions of chapter 25, section 35, of the Revised Laws.

Oct. 14, 1909.

To the Board of Public Works of the City of Pittsfield.

Gentlemen: — The State Board of Health received from you on Sept. 11, 1909, the following application for its approval of the use of water from a tubular well located near the reservoir on Ashley Brook as a source of water supply for the city of Pittsfield: —

The Board of Public Works in behalf of the city of Pittsfield hereby asks the permission and approval of your Honorable Board to use the water from an artesian well, known as well No. 1 and situated above the easterly end of the new reservoir on Ashley Brook, as an additional source of water supply for the city of Pittsfield. The water from said well to be pumped into said reservoir.

The Board has caused the locality to be examined by one of its engineers and has examined the results of analyses of samples of the water. One of these samples collected and sent in by your board soon after the completion of the well shows that the water at that time, while free from organic matter, was very hard and contained a somewhat larger quantity of iron than is found in good well waters. A more recent analysis shows improvement in respect to the hardness of the water but there was a considerable quantity of organic matter present in this sample and the quantity of iron had apparently increased. This sample may have been affected, however, by the construction work being carried on about the well.

No tests of the probable yield of this well appear to have been made as yet, and the information available is not sufficient to enable the Board to advise you definitely as to the probable character of the water which this well will furnish or the quantity that it will yield with continued use. The Board recommends that a test be made by pumping continuously from the well for a period of two weeks or more at as great a rate as practicable and that samples of the water be collected for analysis at frequent intervals, while pumping is in progress.

If you decide to make this test, the Board will, upon the receipt of a request, cause the necessary analyses of the water to be made while the test is in progress and will then advise you as to the use of this well as a permanent source of water supply for the city of Pittsfield.

PLAINVILLE. FEB. 4, 1909.

To the Board of Water Commissioners of the Town of Plainville, MR. JOSEPH F. BREEN, MR. WILLIAM H. NASH *and* MR. W. F. MAINTIEN.

GENTLEMEN: — The State Board of Health has considered your application for the approval of the use of certain tubular wells located near the westerly bank of the Ten Mile River, from 600 feet to 1,170 feet north of West Bacon Street, the most northerly well being about 600 feet south of the well constructed a few years ago as a source of additional water supply by the town of North Attleborough, and has examined the results of analyses of samples of water collected during the pumping tests made since November 24 last and at other times.

An examination of the records of the quantity of water pumped during the various tests indicates that the wells would probably furnish an ample supply of water for the requirements of the town of Plainville. The quality of the water, however, while in most respects satisfactory, is unfavorably affected by the presence of a large quantity of iron, which has not shown a tendency to diminish either during the tests or the subsequent periods of pumping from the wells. A water containing so large a

quantity of iron as that present in the water drawn from these wells would be very objectionable for many domestic uses, and the Board does not at present approve the use of these wells as sources of water supply for Plainville.

Practically all of the samples collected from the wells have been slightly turbid and a small quantity of fine sediment, apparently composed of very fine sand or silt, has deposited from them after standing. These conditions indicate that the water entering one or more of the wells is derived from a stratum of very fine material and that the well or wells so located have not yet been pumped clear. It is not unlikely that by testing the wells separately, it might be found, by shutting off one or more of the wells furnishing water containing iron, that water of good quality can be obtained from the others, though it would very likely be necessary to drive additional wells in order to secure an adequate supply for the town. While no provision appears to have been made for the shutting off of the several wells, such a provision is a very desirable one in a tubular well system, and it would be best to equip each well with a suitable gate, by means of which it can be separated from the others. In this way the wells can be examined separately and the character of the water of each determined.

The Board recommends that you have the wells examined by a competent engineer of experience in matters relating to ground water supplies, that the objectionable wells, if any are found, be separated from the system and additional wells introduced if necessary. The Board will assist you in the examination of the wells by making the necessary analyses of the water of the separate wells and will again consider the question of the approval of the use of these sources when the further investigations and tests suggested have been made.

Reading.

Feb. 4, 1909.

To the Board of Water Commissioners of the Town of Reading.

Gentlemen: — In response to your request for advice as to whether the results of the investigations thus far made with a view to obtaining a ground water supply to replace the present sources are such as to warrant a continuance of those investigations, the Board has caused the localities in which tests have thus far been made to be examined by its engineer and has examined the information presented as to the condition of your present works and the cost of rebuilding, maintaining and operating the filters.

Of the various tests thus far made the most favorable are those found in the neighborhood of a small tributary of the Ipswich River south of that stream, about a mile and a half west of your present filter gallery.

It appears that both of the test wells thus far driven in this locality penetrated a deep stratum of porous soil, from which water could be pumped freely with a hand-pump. The soil in the region about the wells appears to be coarse and porous over a large area, and taken in connection with the character of the soil as shown by the wells, the indications are favorable, in the opinion of the Board, for obtaining water in large quantity from the ground in that locality.

The only available information as to the quality of the water is that furnished by the analyses of two samples collected from the wells before pumping had been continued for a sufficient length of time to obtain clear water. The results show, however, that the water was soft and free from organic matter and these tests indicate that water of excellent quality can be obtained from the ground in that locality.

It appears that the reconstruction of the works for purifying the water taken from the present filter gallery has become necessary and that you estimate that the cost of rebuilding the filters will be about $13,000, while the cost of their maintenance will amount to about $1,000 per year. It will still be necessary with the new filters to use chemical precipitants in order to purify the water, and it is unlikely that even with the best management of your proposed filters the water would be equal in quality to a good ground water.

If a water supply for the town of Reading should be taken from the ground in the region in which your recent tests were made, the works would probably cost somewhat more, in the beginning at least, than the works necessary for purifying the water of your present filter gallery, but taking into account the cost of renewing, maintaining and operating the filters, the difference would not be great.

Considering the objectionable character of the water of your present sources of supply and the decided advantages which a good ground water supply would have over that of your present sources, even after filtration, the Board advises that you continue the tests by driving additional wells in the neighborhood of those already put in near Grove Street, about a mile and a half west of the filter gallery. If the additional wells show that the deep stratum of porous soil penetrated by the previous tests underlies a considerable area in this locality, the next step will be to connect together a number of the wells and pump from them continuously for a period of at least two weeks and at a rate of as much as 300,000 gallons per day, to obtain more definite information as to the yield of the wells and the quality of the water.

The Board will assist you in further investigations by making the necessary analyses of water and will give you further advice as to improving your water supply when the results of the further tests are available.

Shelburne (Shelburne Falls Fire District).

June 3, 1909.

To the Committee on Water Supply of the Shelburne Falls Fire District, Mr. W. S. Ball, *Secretary.*

Gentlemen: — The State Board of Health received from you on April 28, 1909, a communication stating that the investigations as to obtaining a ground water supply for Shelburne Falls have been discontinued for lack of funds, and that, since the results of the tests thus far made have not disclosed any source from which a supply of ground water can be obtained in the neighborhood of the village, your committee desires to recommend to the district the taking of water from Fox Brook to be supplemented with water from Houghton's Brook, so called, when an additional supply is required.

The Board has caused Fox Brook and other possible sources of supply in the neighborhood to be examined by its engineer and has considered the available information relative thereto. While the tests thus far made for the purpose of obtaining a ground water supply have not disclosed any place from which an adequate supply of good water can be obtained in the neighborhood of the village, the tests have not yet covered some of the more favorable localities and consequently do not show definitely whether an adequate supply of ground water can be obtained in the region about the village or not.

Of the various sources proposed Fox Brook appears to have advantages which make it the most desirable of the surface water sources under consideration, although this cannot be definitely determined until a more careful study has been made both of the Fox Brook watershed and the watershed of Houghton's Brook and the two small streams northerly thereof. The watershed of Fox Brook apparently contains very few dwelling houses, which, the Board is informed, are now uninhabited and can be purchased by the village if desirable at a very small cost. The greater part of the watershed is wooded and with reasonable care danger of pollution of the water can be prevented. The water, while somewhat hard, is on the whole of good quality for water supply purposes, but the quantity of water that would be furnished by the natural flow of the stream would probably be insufficient for the requirements of the district in the drier portion of the year. By the construction of a reservoir holding about 5,000,000 gallons, however, it would be practicable to obtain an adequate supply of water from that source for all reasonable requirements of the village. The watershed has not been examined carefully to determine whether a suitable reservoir can be constructed upon the stream, but it is probable that a site can be selected where the storage indicated can be secured.

The chief objections to the taking of water from Fox Brook for the supply of the Shelburne Falls Fire District are: the possible danger of pollution, which in this case can be prevented by the purchase and removal of the buildings within the watershed and by proper inspection; and the difficulty of constructing a suitable reservoir of the size indicated, from which an excessive quantity of water will not be lost by leakage. Experience has shown that reservoirs constructed for the storage of water upon such streams as Fox Brook have, in many cases, leaked excessively and such sources have not infrequently been found inadequate very soon after the construction of the works. If the experience of Shelburne Falls in attempting to construct a reservoir on Fox Brook should be similar to that of many other towns and districts, it would be much better for the district to take water from the ground even at a considerable distance from the village than to attempt to develop a supply from Fox Brook. Moreover, a good ground water supply would not only be more reliable in yield and much less difficult to protect from pollution but would furnish water of better quality than Fox Brook.

For the reasons given the Board believes it advisable for the district to secure a ground water supply if possible, but in case it should be impracticable to secure a suitable ground water supply, either Fox Brook or Houghton's Brook used in connection with the streams lying just north of Houghton's Brook would probably be the most appropriate of the various sources that are now available.

SOMERSET (WELLS).

To the Board of Health of the Town of Somerset. DEC. 2, 1909.

GENTLEMEN: — Your attention was called some time ago by this Board to the need of a supply of good water for the inhabitants of the village of Somerset. The Board has recently made a further examination of numerous wells in various parts of the village, and as a result finds that practically all of them are grossly polluted by sewage, and the character of their waters is such as to be likely to be very injurious to the health of those who use them for drinking.

The Board again recommends that steps be taken by the town without further delay to provide an adequate supply of good water for the use of the inhabitants of the thickly settled portion of this town.

SOUTHBOROUGH. FEB. 4, 1909.

To the Water Supply Committee, Southborough, Mass., Messrs. ROBERT M. BURNETT, CHARLES L. FAIRBANKS, PAUL S. LINCOLN *and* FRANCIS WRIGHT.

GENTLEMEN: — The State Board of Health received from you on Dec. 15, 1908, an application for advice as to a water supply for the town

of Southborough, accompanied by a plan by your engineer, showing a proposed piping system and standpipe for supplying the four principal villages of the town, viz., Southborough Center, Fayville, Southville and Cordaville, with water to be taken from the ground on the south side of the Worcester turnpike about half a mile west of the village of Fayville, and on the southerly side of the Sudbury Reservoir of the Metropolitan Water Works.

It appears that three test wells have been driven in this locality to depths ranging from 21 to 31 feet, each of which penetrated a gravel stratum, from which water could be pumped in small quantities with a hand-pump. Tests have also been made in the locality known as Bagley's gravel pit on the westerly side of the Sudbury Reservoir south of the New York, New Haven and Hartford Railroad and at the Buck Farm on the easterly side of the reservoir about three-quarters of a mile north of the railroad. At the gravel pit three wells were driven to depths of 20, 15 and 10 feet respectively, but it is reported that in each case ledge or boulder was finally encountered. The tests at the Buck Farm were apparently unfavorable, all of the wells striking ledge or boulders and but little water being obtainable from any of them.

The Board has caused the localities indicated to be examined by one of its engineers and samples of the water from two of the test wells near Fayville and one in the gravel pit to be analyzed.

The water of all of these samples was turbid and contained much mineral matter, so that it is difficult to judge of their true character. The water of the wells at the location near Fayville was free from organic matter, and the indications are that water of good quality could be obtained from the ground at that place. The water of the well at Bagley's gravel pit showed considerable evidence of pollution, and the indications furnished by this sample are not favorable for obtaining good water in that locality.

Regarding the quantity of water obtainable from the locality near Fayville, the tests thus far made are not very favorable to obtaining enough water there for the requirements of Southborough. On account of the small size of the watershed the yield of wells at that place would be dependent largely upon the quantity of water which would filter through the ground from the Sudbury Reservoir, but as the wells did not furnish water very freely, the indications cannot be said to be favorable for obtaining any very considerable quantity of water in that way, especially at times when the reservoir is drawn down.

Considering the unfavorable indications furnished by these tests, the Board does not recommend the construction of works for taking water for the supply of Southborough from the sources indicated.

There appear to be several localities at a somewhat greater distance

from the principal villages of the town where the indications are favorable for obtaining water from the ground in considerable quantity, and the Board recommends that further and more thorough tests be made at some of the more favorable places before a source of water supply for the town is definitely selected. The Board will assist you in further investigations by making the necessary analyses of water and will give you further advice when you have the results of further investigations to present.

Stockbridge.

Dec. 2, 1909.

To the Stockbridge Water Company, Stockbridge, Mass.

Gentlemen: — Complaint has been made of the character of the water supplied to the town of Stockbridge, which is affected at times by a disagreeable taste and odor which make the water objectionable for drinking and other purposes, and in response to this request the Board has caused the source of supply to be examined by its engineer and has considered the results of numerous chemical and microscopical analyses of the water covering a period of many years.

The results of these examinations show that the water is affected from time to time by the presence of large numbers of microscopic organisms, including Uroglena and Synura, which occur principally in the winter and spring seasons, and Anabæna, which is ordinarily most abundant in the late summer and early fall. All of these organisms are known to impart to water a disagreeable taste and odor when present in considerable numbers, such as have been found in the waters of Lake Averic. The cause of the presence and growth of these organisms in the waters of ponds and reservoirs is not known. They occur in greater numbers in polluted ponds and reservoirs and in those which are shallow and contain considerable quantities of organic matter in their bottoms or are affected by swampy watersheds than in reservoirs which are free from organic deposits and are fed from clean watersheds. The watershed of Lake Averic is uninhabited and its waters are not polluted by sewage. There is a small swamp on the watershed and considerable organic matter on the bottom of the pond, the original level of which has been raised by a dam at its outlet. It would apparently be practicable to drain the swamp without difficulty, but to remove the organic matter from the pond itself would involve a large expense.

The best practicable plan of improving the quality of the water taken from this source would be to filter it through sand, and there is no doubt, in the opinion of the Board, that this water can be effectually purified by filtration and aeration so that it will be at all times free from objectionable taste or odor. The location of the lake at a level considerably above the pumping station affords a favorable opportunity for filtering the

water before it is pumped for the supply of the town, and it is probable that the cost of the necessary filtration, including aeration, would not be excessive.

From such investigations as the Board has made it does not seem likely that a better plan can be devised for obtaining a supply of good water for the town of Stockbridge than by filtering the water of Lake Averic. The water of many of the other sources in the neighborhood of the town has been analyzed in previous years, but the results indicate that these waters are hard and consequently less desirable for water supply purposes than the water of Lake Averic, while none of the surface water sources appears to have any advantage in other respects over the latter source.

Investigations were made several years ago with a view to obtaining a supply of water from the ground in the valley of the stream below the outlet of Lake Averic, and other sources were also examined for a similar purpose, but the results show that these waters were affected by an excessive hardness which would make them objectionable for domestic purposes. These tests have not, however, covered all of the available places in the region about Stockbridge, and it is possible that a ground water supply might be obtained at some point where it would be unaffected by the limestone which is the source of the hardness of these waters.

The Board recommends that you have a careful examination made, under the direction of an engineer of experience in such matters, of the practicability and probable cost of purifying the water of Lake Averic by filtration so as to remove the disagreeable tastes and odors therefrom caused by the organisms which appear in this water at different seasons of the year.

Westfield (Westfield State Sanatorium).

Dec. 2, 1909.

To the Board of Trustees of the Westfield State Sanatorium, Dr. Henry D. Chadwick, *Superintendent.*

Gentlemen: — In response to your request for an examination of a group of tubular wells located in the valley east of the buildings of the Westfield State Sanatorium and advice as to the use of these wells as sources of water supply for the institution, the Board has caused the wells and their surroundings to be examined and samples of water sent in by you during a pumping test between October 12 and October 19 to be analyzed.

It appears that five wells were used in making the test, all of which were located on the westerly side of the brook a little over 200 feet east of the highway and about 300 feet from the nearest of the institution buildings. The wells are located from 30 feet to 120 feet from the brook

and were driven into porous soil at depths of from 15 feet to 20 feet. The Board is informed that during the pumping test water was pumped from the wells at rates varying from 30,000 gallons per day in the beginning to 80,000 gallons per day during the last twenty-four hours. The records of the height of ground water before, during and after the test are not very complete or satisfactory, but they indicate that the water fell rapidly during the last part of the test and that after the test was completed the recovery of the water table was very slow. These conditions cannot be regarded as favorable for obtaining here a sufficient quantity of water for the supply of the institution if the amount used in proportion to the population is as great as in other institutions in the State.

The analyses of samples of water sent in daily between October 12 and 18, inclusive, show that the water had been at some time considerably polluted, though subsequently well purified in its passage through the ground before entering the wells. Most of the samples were slightly turbid and contained a very small quantity of sediment, and the quantity of iron present was larger than is found in good ground waters. While the water at the time this test was made was probably safe for drinking, the evidences of previous pollution and the presence of a considerable quantity of iron are indications that its quality may deteriorate with continued use. The pollution of the water is very probably due largely to sewage from the dwelling house near the highway northwest of the wells, though it may be due in part to polluted water from the brook finding its way through the ground to the wells.

Under the circumstances, the Board questions the desirability of these wells as sources from which to take water for the permanent supply of the institution, and if used temporarily the water should be analyzed at frequent intervals in order that its use may be discontinued if deterioration occurs.

Weston.

Oct. 14, 1909.

To the Weston Water Company, Weston, Mass., Mr. Percy Warren, *President.*

Gentlemen: — In response to your request of Sept. 7, 1909, for advice as to taking water from the ground near Stony Brook a short distance below Kendal Green, as an auxiliary water supply for the town of Weston, the Board has caused the locality to be examined by its engineer and has examined the results of observations made while pumping from a group of eight tubular wells in this locality at various times between August 28 and September 15.

The results of the pumping tests indicate that an ample quantity of water for the requirements of the town of Weston could probably be obtained from the ground at the location selected. Analyses of the water collected at frequent intervals during the pumping tests indicate, how-

ever, that this water, while in most respects of good quality for the purposes of a public water supply, would be likely to be affected by the presence of an excessive quantity of iron, which would make it objectionable for many domestic purposes, and the Board cannot recommend the use of these wells as sources of water supply for the town of Weston.

The soil of the region in which the recent tests were made appears to be coarse and porous over a large area, and it is probable that ground water which will not be affected by an excess of iron can be obtained from some place in this region. Considering the circumstances, the Board recommends that the tests be continued and that further wells be driven in this region with a view to obtaining water which will be of good quality and free from an excess of iron.

The Board will assist you in further investigations, if you so request, by making the necessary analyses of the water, and will give you further advice when you have the results of further tests to present.

Winchester.

Under the authority of section 113 of chapter 75 of the Revised Laws, rules and regulations were made by the Board on April 1, 1909, for preventing the pollution and securing the sanitary protection of the waters of North Reservoir, South Reservoir and Middle Reservoir and their tributaries, used by the town of Winchester as sources of water supply.

In addition to the foregoing, the Board has advised the following cities, towns and persons relative to spring waters, waters used for the supply of factories, public wells or wells used by a number of families; but as these matters are for the most part of minor importance, the communications of the Board in these cases have not been printed. Copies of them are on file in the office of the Board.

Arlington, well of Standard Jewelry Company.
Auburn, well at Pondville schoolhouse.
Boston, well at Boylston Brewery.
Cambridge, well at Harvard Square.
East Bridgewater, well at Beaver School.
East Bridgewater, ponds used for supply of M. V. M. camp.
Fairhaven, well at Wigwam Beach.
Framingham, well in Saxonville.
Framingham, water supply of Framingham Shoe Company.
Goshen, well of H. G. Bennett.
Grafton, spring in Saundersville.
Kingston, well at Wapping School.
Lakeville, King Philip Spring.

Lawrence, well at Central Fire Station.
Lawrence, well on Pleasant Street.
Leicester, Leicester Polar Spring.
Littleton, water supply of town hall and drinking fountain.
Lynn, well of Lydia Pinkham Medicine Co.
Lynnfield, Sagamore Spring.
Mansfield, well at Hartwell School.
Marion, wells.
North Reading, well at railroad station.
Norton, well at Wheaton Seminary.
Palmer, wells at Thorndike & Wire Mill Village.
Peabody, well in Wilson Square.
Plymouth, Elder Brewster Spring.
Plymouth, well of George Mabbett & Sons.
Reading, well.
Reading, well of O. P. Symonds & Sons.
Rowley, Hillcrest Spring.
Salem, wells of G. C. Vaughn Leather Company.
Seekonk, well of Robert S. Brown.
Springfield, Bircham Bend Spring.
Wareham, well at almshouse.
Westwood, wells in Islington.
Weymouth, Crystal Rock Spring (two).
Winchendon, well of William Brown & Sons.
Winchendon, spring of Nelson D. White & Sons.

Ice Supplies.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sources of ice supply: —

Danvers.

To the Board of Health of the Town of Danvers. Sept. 2, 1909.

Gentlemen: — In response to your request of Aug. 10, 1909, for an examination of Putnam's Pond, which is used as a source of ice supply, and advice as to whether the ice obtained therefrom is suitable for domestic use, the State Board of Health has caused the pond and its surroundings to be examined and samples of the water and ice to be analyzed.

This source was examined in 1901 in accordance with the request of the board of health of Danvers, and after the examination your board was advised as follows: —

As a result of its investigations the Board is of the opinion that the ice of Putnam's millpond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no par-

ticles of foreign matter, might safely be so used. The only safety in using such ice lies in a proper inspection under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

The Board would advise that no ice be cut in the immediate neighborhood of the feeders of the pond, the flow from which may cause matters to become entangled in the ice, or at any place in the pond where the water is shallow and there would be danger that weeds or organic matters from the bottom of the pond might be taken up by the ice.

It appears, from information furnished the Board during the recent examination and from the appearance of the ice taken from the ice-house near the shore of the pond, that the recommendations of the Board relative to the treatment of this ice have not been followed, and that the thickness of the ice has been increased by flooding. As a result of its recent examinations the Board sees no reason to change the advice given in its previous communication, and unless the recommendations quoted above are to be strictly followed, the use of ice from this pond, which is greatly exposed to pollution, should be prevented.

Lexington.

March 4, 1909.

To the Board of Health of the Town of Lexington.

Gentlemen: — In accordance with your request for an examination of ice harvested from Simonds Pond and Granger's Pond in Lexington during the past winter, the Board has caused samples of ice from these sources to be examined and has made a further examination of the surroundings of the ponds.

The results of the analyses show that the ice of Simonds Pond contained a somewhat larger quantity of organic matter than is found in good ice, but was in other respects of good quality, and it is probable, in the opinion of the board, that it can safely be used for domestic purposes.

The ice of Granger's Pond was similar in quality to that of Simonds Pond, and, while the quantity of organic matter present was larger the number of bacteria found was smaller than in the ice from Simonds Pond, and under the circumstances it is probable that this ice also may safely be used for domestic purposes.

The circumstances affecting the quality of the ice taken from Granger's Pond were much more favorable during the past very dry season than they are likely to be under ordinary conditions, and the Board cannot recommend the continued use of Granger's Pond as a source of ice supply.

Simonds Pond is very shallow and under the conditions existing there last fall the source was a very objectionable one from which to take ice for domestic purposes. It appears that the pollution of this source has now been removed and it is probable that the ice taken from this source may safely be used for domestic purposes in future, but it will be important to reject all snow ice, including the first inch of ice forming upon the pond, and especially to reject all ice from this source containing particles of foreign matter.

MELROSE. Nov. 11, 1909.

To the Board of Health of the City of Melrose, CLARENCE P. HOLDEN, M.D., *Chairman.*

GENTLEMEN: — In response to your request for an examination of Ell Pond in Melrose and of the ice taken therefrom, the Board has caused the pond and its surroundings to be examined and samples of the water and ice to be analyzed.

The watershed of the pond is densely populated, but the district is provided quite thoroughly with sewers connected with the north metropolitan sewerage system, with which nearly all of the buildings have been connected. The pond receives, nevertheless, considerable pollution from barns and other buildings, as well as from cultivated areas along its tributaries, and its water contains a much greater quantity of organic matter than was present at the time of previous examinations made at the request of your board in 1901, when the question of the advisability of continuing the use of this pond as a source of ice supply was under consideration.

Examinations of the ice in ice-houses on the shore of the pond show that it consists in part of snow ice, and analyses show that the snow ice contains a much greater quantity of organic matter and bacteria than is found in good ice. The conditions, on the whole, are found to be similar to those which existed in 1901 when you were advised concerning the use of ice from this source as follows: —

Ell Pond is situated in the central portion of Melrose, and receives the drainage from a territory containing a dense population, and is evidently considerably polluted by sewage.

Numerous samples of ice collected from various parts of this pond, both during the winter just passed and the previous winter, have been analyzed by the Board; and, judging from the results of all its examinations, the Board is of the opinion that the ice of Ell Pond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no particles of foreign matter, might safely be so used.

Under the existing conditions, the only safety in using such ice lies in a proper inspection, under your direction and control, to insure the removal

from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

It does not appear that the recommendations of the Board as to the removal of snow ice and the first inch of clear ice before using are now followed, since all of the ice examined in the ice-houses near the pond was found to have a layer of snow ice on top of the cake.

As a result of its investigations the Board sees no reason to modify the opinion as to the character of ice taken from this source expressed in the reply quoted above. The Board advises that the use of ice taken from Ell Pond be prevented unless the ice taken from this source shall be properly inspected so as to secure the removal and rejection of all snow ice, including the first inch of ice that forms upon the pond and all ice containing particles of foreign matter.

Quincy.

June 3, 1909.

To the Board of Health of the City of Quincy, Mr. William J. Walsh, *Chairman.*

Gentlemen: — In response to your request for an examination of the ice of Manet Lake at Hough's Neck and advice as to its quality the Board has caused the source of supply to be examined by one of its engineers and samples of the water and ice to be analyzed.

The lake is small and very shallow and has a very limited drainage area. The water contains an excessive quantity of organic matter and the ice harvested from the lake during the past winter contains a larger quantity of organic matter and a greater number of bacteria than are found in good ice. It is not advisable, in the opinion of the Board, to use this ice where it may come in contact with food or drinking water, and the Board recommends that the further use of Manet Lake as a source of ice supply be discontinued.

Rockland.

To the Board of Health of the Town of Rockland. May 6, 1909.

Gentlemen: — In accordance with your request for an examination of the ice from Studley's Pond, Loud's Pond and Cushing's Pond, so called, located in the town of Rockland, and advice as to its quality, the Board has caused the ponds and their surroundings to be examined and samples of the water and ice of each to be analyzed.

The watershed of Loud's Pond is very sparsely inhabited and its waters are not exposed to serious danger of pollution. The water is highly colored and contains a large quantity of organic matter, evidently derived

from contact with vegetable matter in the bottom of the pond and the extensive swamps within its watershed. The ice also contains a larger quantity of organic matter than is ordinarily found in good ice, but the number of bacteria present in the sample analyzed was very small, and considering the circumstances the Board is of the opinion that the ice of this pond may safely be used for domestic purposes.

Studley's Pond is fed in part by the stream which flows from Loud's Pond and in part by other streams, one of which drains part of the thickly settled portion of Rockland, containing a dense population. The ice taken from this pond during the past year was probably harvested under more favorable conditions than would ordinarily be the case, and it is probable that this ice can safely be used for domestic purposes if the first inch of ice that formed upon the pond and all snow ice formed above it shall be removed before using, and all ice containing particles of foreign matter rejected. This pond is not a desirable source of ice supply under present conditions and measures should be taken to prevent danger of its pollution by sewage if its use as a source of ice supply is to be continued.

The water of Cushing's Pond, located on the easterly side of the village, has a higher color and contains a greater quantity of organic matter than that of Loud's Pond, and in this case also the color and organic matter are doubtless derived largely from the bottom of the pond and from the swamps on its watershed, but Cushing's Pond receives also the drainage from a considerable part of the densely populated portion of the main village and the same conditions affecting the use of ice from this source should be observed as in the case of Studley's Pond.

It will be difficult to prevent the pollution of Studley's and Cushing's ponds unless a sewerage system shall be constructed in the village, but unless serious danger of pollution of these sources during the period when the ice is forming shall be prevented, their use as sources of ice supply should be discontinued.

In addition to the foregoing, the Board has advised the following city and towns relative to sources of ice supply.

Malden, Swain's and Towner's ponds.

Williamstown, reservoir in Flora Glen.

Winchendon, mill pond of Baxter D. Whitney & Son.

Sewerage and Sewage Disposal.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to sewerage and sewage disposal: —

Adams.

June 3, 1909.

To the Board of Health of the Town of Adams.

Gentlemen: — The State Board of Health received from you on March 10, 1909, an application for advice as to a proposed system of sewerage for the town of Adams, accompanied by plans and a report of your engineer, Mr. William S. Johnson, describing the proposed works.

The plans submitted provide for a system of pipe sewers to collect the sewage of the town into a main sewer and convey it to a point on the westerly side of the Hoosick River, close to the boundary line of the city of North Adams, where it is proposed to purify it by intermittent filtration and discharge the effluent into the river. It is not expected that the sewers will all be built in the beginning but that portions of the system will be constructed from time to time as they may be required, and until such time as purification works become necessary it is proposed to discharge the sewage through a temporary outlet directly into the Hoosick River, about 600 feet north of Lime Street.

The Board has carefully examined the report and plans submitted therewith, and has considered the present conditions resulting from the discharge of sewage and manufacturing waste into the Hoosick River and its tributaries in the town of Adams, and the probable future requirements of the town in the matter of sewerage and sewage disposal.

Up to the present time sewers have been constructed in various parts of the town which discharge either directly into the Hoosick River or into its tributaries through numerous outlets. These outlets are in many cases located in close proximity to dwelling houses, and the conditions about them are very offensive. In some cases sewage is discharged into small tributary streams which become dry during the summer months, so that these streams become open sewers in densely populated localities. During the year 1908 twenty-four sewer outlets were examined and in every case the conditions about them were found to be objectionable. Moreover, there are several factories in the town, from all of which both the sewage and manufacturing wastes are discharged directly into the stream without treatment, and in some cases these wastes are very foul.

The existing sewers have not been constructed with a view to making them part of any general system. Many of them are without manholes and some of them receive storm water as well as sewage. Very little information is available concerning them, but it is probable that some of them can be used in connection with the proposed new system. Others

will have to be replaced by new ones, although in some cases they can continue to be used as drains, if all sewage is diverted from them.

It appears to the Board to be very important that the town of Adams should proceed without delay in the construction of the proposed main sewer and such branches as may be necessary to intercept the sewage now discharged into the streams within the town, and remove it to some more suitable place of disposal. The general method of sewerage and sewage disposal presented by your engineer appears to the Board an appropriate one for relieving the present objectionable conditions and providing adequately for the collection and disposal of the sewage of the town for a reasonable time in the future.

The proposed plan of discharging the sewage temporarily into the Hoosick River at a point 600 feet north of Lime Street appears to the Board to be a permissible one under the circumstances, and it is probable that that method of disposal can be continued for a few years after the construction of the works has been begun. It is important, however, to secure in the beginning the land and materials necessary for the purification of the sewage, so that the purification works may be constructed as soon as the increasing pollution of the river makes the removal of the sewage necessary.

Owing to the very unsanitary and objectionable conditions which now exist in the town of Adams and which cannot be improved until a sewerage system has been provided, the Board recommends that the town begin the construction of the proposed works with as little delay as possible and that a sufficient portion of the main sewer be constructed in the beginning to remove all existing nuisances.

Amesbury.

Nov. 11, 1909.

To the Board of Selectmen of the Town of Amesbury.

Gentlemen: — In response to a complaint from residents of Amesbury living in the neighborhood of Congress and Kimball streets alleging the existence of a nuisance caused by a sewer outlet in that neighborhood, the Board has caused the locality to be examined and finds that a considerable quantity of sewage and foul drainage is being discharged into the channel of a small brook near the junction of the streets mentioned and that a great nuisance is caused thereby.

In order to prevent injury to the public health from these conditions it will be necessary, in the opinion of the Board, to prevent the further discharge of sewage into this small stream or its tributaries. There appears to the Board no practicable plan of preventing this nuisance except by removing the sewage from the present outlet to some suitable

place of disposal. There are other localities in this town which are greatly in need of sewerage, and the Board recommends that the town again take up the plan of providing a general system for the collection and proper disposal of the sewage of the thickly settled portions of the town and dispose of these nuisances in accordance therewith.

Amherst.

Oct. 14, 1909.

To the Board of Health of the Town of Amherst, H. G. Rockwell, M.D., *Chairman.*

Gentlemen: — The State Board of Health received from you on September 7 an application for advice as to a proposed system of sewerage in North Amherst, accompanied by a sketch showing the location of the proposed sewers. The plan provides for constructing a sewer from a point in Pine Street a short distance east of Church Street, through Pine and Meadow streets and across vacant land north of Meadow Street to the neighborhood of the Mill River, where it is proposed to construct one or two large cesspools on the easterly bank of the stream north of the highway and discharge the overflow either into the tail-race flowing from the site of an old mill or directly into the main stream. As shown by the sketch submitted with your application, there are eighteen houses on the line of the main sewer from which sewage might be discharged into it, but you state that only two or three are provided as yet with bath-rooms or waterclosets, although others are likely to be so provided in the near future if the sewer is built.

The Board has caused the locality to be examined by one of its engineers and has considered the plan presented. The proposed sewer would provide a method for collecting and disposing of the sewage of the more densely populated portion of the village of North Amherst, and it is unlikely that the small quantity of sewage that would be discharged from this sewer would create a nuisance in the stream below the proposed outlet; but, while the stream passes through an uninhabited territory for a considerable distance below the proposed outlet, it subsequently flows through the village of North Hadley before reaching the Connecticut River and it is not desirable, in the opinion of the Board, to use this stream as a place of sewage disposal unless the sewage shall be purified. The proposed cesspools or settling tanks would not be likely to remove any considerable quantity of organic matter from the sewage except in the beginning.

The best plan of treating this sewage would be to apply it to land, and a very small area — about one-eighth of an acre — would be adequate for the purpose if the soil consisted of sand or gravel and could be properly underdrained. The land in the valley of the river near the

proposed sewer outlet does not, however, appear to contain soil adapted for the purpose, and in order to purify the sewage in this locality, it would be necessary to construct the filters artificially. Gravel or sand of suitable quality for the purpose can doubtless be obtained at no great distance, and filters which will purify the sewage efficiently can be constructed near the river at a reasonable cost. In this way a satisfactory method of disposing of the sewage from the sewer in question can be provided and the cost would not be excessive. The Board recommends that if the sewer be constructed a suitable filter bed be provided for purifying the sewage before it is discharged into Mill River.

While it is important that the sewer now desired in North Amherst be constructed as soon as practicable, it is very important, in the opinion of the Board, that before this work is begun the question of the disposal of the sewage of other thickly settled portions of the town be given immediate and careful consideration, since the requirements of all parts of the town likely to need sewerage may make desirable some modification in the plan now under consideration.

An examination of the present sewer outlets shows that the so-called "north outlet," which now discharges upon the ground about a mile northwest of the main village, is a serious nuisance and that odors from it are noticeable at dwelling houses in the neighborhood. The sewage from another small outlet located near Dana Street, a short distance west of the main village, discharges into a depression in the ground and forms an offensive open cesspool, which is very objectionable.

The main outlet for the sewage of the greater portion of the town discharges into Fort River, about a mile and a half southeast of the main village. This outlet was built apparently about eighteen years ago, and the Board, after considering the plans presented at that time, advised you concerning them as follows, under date of June 18, 1891: —

The State Board of Health has carefully considered your application for advice with regard to the disposal of the sewage of that portion of Amherst now draining through the Snell and Fearing brook sewers. The plan which you have presented, proposes to unite the sewage from these two systems and convey it directly to Freshman or Fort River where it passes through land of E. Hastings, not very far above the New London Northern R. R.

With the growth of the town it will probably become necessary to purify the sewage by intermittent filtration through land before it is discharged into the river, but for the present the Board advises that the sewage be passed through a properly designed settling tank, the outlet pipe of which turns down at its entrance so as to allow only those parts of the liquid which lie between the deposits at the bottom and the floating matter at the surface, to enter it and be discharged into the river.

The tanks should be provided with another pipe closed by a gate through

which the deposited and floating materials may be drawn to an area of sandy land at a lower level, where, after draining, the deposit may be turned under the surface or otherwise disposed of. This tank should be thus flushed out as often as twice a week.

An examination of this outlet and of the stream below shows that the settling tanks are rarely cleaned out and do not remove any considerable quantity of suspended organic matter from the sewage, and that paper, rags and other matters from the sewage have been collected in large quantities on the sides and bottom of the stream below the outlet.

Analyses of the water show that the river is becoming very badly polluted below this outlet and it is evident that the time has come when more effective provision should be made for preventing the pollution of this stream by the sewage of the town.

It appears to the Board very important for the interests of the town that the further pollution of Fort River be prevented and the other nuisances caused by sewage removed as soon as practicable, and the Board recommends that the town take up at once the question of sewerage and sewage disposal for all of the thickly settled districts, including not only the areas in which sewers have already been built or which are at the present time in need of sewers, but also the areas which may require them in the not distant future; and that plans be prepared for the collection and proper disposal of all of the sewage. This work should be done under the direction of an engineer of experience in matters relating to sewerage and sewage disposal, and the Board will, upon request, give you such information and assistance as it can in the progress of the work and will advise you as to any plan for the collection and disposal of the sewage that you may desire to present.

Canton (Massachusetts Hospital School).

April 1, 1909.

To the Trustees of the Massachusetts Hospital School, Canton, Mass., Dr. J. E. Fish, *Superintendent.*

Gentlemen: — The State Board of Health received from you on March 29 an application for advice as to a proposed system of sewage disposal for the hospital, accompanied by a plan showing the location of the proposed sewer and filter beds. The plan provides for collecting the sewage from the hospital buildings, except the power station, and conveying it in a westerly direction to filter beds to be located near the westerly boundary of the lands owned by the school, where it is proposed to purify it by intermittent filtration. Two filter beds are shown on the plan submitted, each having an area of 0.15 of an acre.

The Board has caused the locality to be examined by one of its engineers and has examined the plans presented. The sewage from the institution at the present time overflows upon the ground, where it collects in a pool which gives off a very offensive odor, noticeable at the hospital buildings. It is very important that adequate sewage disposal works be provided as soon as possible.

The point selected for the location of the disposal works is distant more than 1,000 feet from the hospital, and the soil at this place is evidently of good quality for sewage disposal purposes. There are no buildings in the neighborhood and the sewage of the institution can without doubt be purified satisfactorily by the plan submitted until the population of the institution becomes considerably greater than at present. It is not desirable, however, to locate the filter beds so near the lands of the adjacent owners, and the Board recommends that the filters be located as much as 200 feet from the boundary of the institution grounds. There is already a considerable growth of trees between the proposed filtration area and the hospital buildings, and the Board recommends that additional trees, especially evergreens, be planted all about the area to screen it from view.

Dracut (American Woolen Company).

Dec. 15, 1909.

To the American Woolen Company, Boston, Mass.

Gentlemen: — The State Board of Health received from you, through your engineer, in February, 1908, a communication stating that works had already been completed for the purification of the manufacturing wastes at the Beaver Brook mills, at Collinsville, for the purpose of preventing the pollution of Beaver Brook, and requesting the advice of the Board as to the best method of preventing the pollution of the brook by these wastes and the adequacy for this purpose of the works which had been constructed, and in response to this request the Board has caused the disposal works to be examined by its engineer and samples of the manufacturing wastes, both before and after treatment, to be analyzed.

These examinations, made on five occasions at varying intervals in the past two years, show that the works were then purifying satisfactorily the wastes being treated by them, and the quantity of organic matter in the effluents discharged from the underdrains of the filters into Beaver Brook, as shown by the albuminoid ammonia, is less than is found in the water of Beaver Brook above the mill. The condition of Beaver Brook below the works has not been objectionable, and the average quantity of organic matter found in the water at the time of these exami-

nations has been the same as the quantity found in the water above the mill.

The examinations of the settling tanks and filter beds show that a large portion of the objectionable organic matter contained in the manufacturing waste conveyed to the disposal works is removed by sedimentation in the settling tanks. These tanks have contained at times a large deposit of sediment, and it is probable that by emptying the tanks and removing the sediment which accumulates in them more frequently a larger proportion of the suspended organic matter can be removed from these wastes before they are applied to the filter beds than has hitherto been the case. The frequent cleaning of the settling tanks is of great importance in the purification of these wastes, since the suspended matters tend to clog the filters and reduce the rate at which they can be operated, besides increasing the cost of operation and maintenance.

The filter beds in the course of their operation have become somewhat uneven, so that the sewage has a tendency to collect in pools, causing a portion of the area to receive a large quantity of the waste while other portions receive little or none. Such a condition is likely to cause a decrease in the efficiency of the filters, and it is very important that the filters be brought to an even grade sloping slightly away from the points at which the liquid is applied in such a way that it may reach evenly all parts of the filter. The trenches in winter should be arranged to produce a similar result.

The rate at which the filters have thus far been operated appears to have been about 90,000 gallons per acre per day, and it is probable that a higher rate could be maintained if necessary. It is desirable that the quantity of waste discharged upon the filters be measured and that a record of the measurements be preserved.

The method now in use for purifying the wastes from this mill appears to the Board the best practicable one for preventing the pollution of Beaver Brook, and the present works, while properly operated, are, in its opinion, adequate for the treatment of the quantity of polluted manufacturing waste now discharged from this mill, which appears to amount to about 400,000 gallons per day. If the suggestions herein contained are followed it is likely that the filters will continue to be adequate for present needs and may be found capable of purifying a somewhat larger quantity of waste than is now discharged upon them.

Hudson.

July 1, 1909.

To the Board of Selectmen of the Town of Hudson.

Gentlemen: — The State Board of Health, after a careful examination of the filter beds used for the purification of the sewage in the town of Hudson, finds that they ceased in the latter part of 1908 to purify the sewage satisfactorily and that the sewage now being applied to them is not efficiently purified before it is discharged into the Assabet River; and the Board, in accordance with the provisions of Chapter 433 of the Acts of the year 1909, hereby requires that the sewage filters be so operated as to purify efficiently the sewage applied to them.

Aug. 25, 1909.

To the Board of Public Works of the Town of Hudson.

Gentlemen: — The State Board of Health received from you on August 13, through your engineer, a plan showing a proposed extension of the sewage disposal works of the town of Hudson, which provides for the construction of eight new filter beds having an aggregate area of 2.8 acres, increasing the number of filter beds, including the sludge bed, to 24, and the aggregate area to 10.2 acres. Of the new filter beds, four, having an aggregate area of 1.5 acres, are to be located on the easterly side of the present filters, and four smaller beds, having an aggregate area of 1.3 acres, on the westerly side, the size of the latter beds having been limited in order that no part of the area shall come within 200 feet of Cox Street.

Three lines of underdrains are shown in each bed, discharging into the main underdrain, which passes along the northerly side of the area and connects with the effluent drain leading to the Assabet River. At the points of connection with the existing underdrain it is proposed to provide an opportunity for the collection of samples of the effluent of each of these two groups of filter beds, before it mingles with the effluent from the other filters. The depth of filtering material, as shown by the plans, is to be about 5 feet.

The Board has caused the location of the proposed new filter beds to be examined by its engineer and samples of the soil from the test pits on these areas to be analyzed, and has considered the plans presented.

The soil at the location of the proposed filter beds is quite variable in character, but much of it beneath the surface layers of loam and subsoil is of good quality for the purification of sewage. Soil of good quality for the purpose is also found in the higher lands adjacent to the proposed filters, and in the opinion of the Board, with proper care in the selection of the filtering material and construction of the works, the proposed

filter beds will be well suited for the purification of sewage by intermittent filtration.

The Board has also, in response to the request of your commission and of the special committee of the town, examined carefully the condition of the present filters, to determine the extent to which each has been clogged by the excessive quantity of fats discharged upon them within the past year, and as to the best method of restoring these filters to such a condition that they will purify properly a reasonable quantity of sewage.

It has not been practicable within the time available to make a thorough examination of all of the filters, since, under existing conditions, some of the filters are completely covered with sewage, and on some of the others standing pools remain for a long time after the application of sewage has ceased. It has been practicable, however, to obtain samples of the soil at various depths from 8 of the 16 filters, the beds examined being the following: Nos. 1, 3, 4, 5, 9, 10, 12 and 16. The samples of soil were collected in all cases from at least two pits in each filter bed, and the results show that the sand at the surface and for a varying distance beneath it contains a large quantity of fatty matter. This matter is evidently derived largely from the wool scouring waste which has been discharged into the sewers during the past year. It is a stable body, which is but slowly changed or destroyed in sand filters, and if the sand, when seriously affected with this matter, were allowed to remain on the filters, a considerable period of time would undoubtedly elapse before the filters would return to a condition in which they would purify the sewage effectually. In fact, this matter might remain in the filters for several years with little change.

The results of the analyses of samples from the beds thus far examined indicate that, with the exception of bed No. 5 at least from 3 to 6 inches in depth of sand will have to be removed from each filter before it can be brought into a serviceable condition for the purification of sewage, and in the case of bed No. 5, the removal of a greater depth than 6 inches may be necessary.

In order that it may be practicable to remove the clogged sand from the present filters and operate them at a sufficiently low rate to allow them to recover their efficiency in the purification of sewage, it will be essential, in the opinion of the Board, to enlarge the filtration area, and the Board recommends that the construction of the proposed additional filters be begun at once.

The Board will, as soon as practicable, complete the examination of the remaining filter beds of the present group to determine the depth to which they are affected by organic matter and fats, and the amount

of material which it is desirable to remove from them, and will then advise you more definitely as to the treatment of these filters.

The plan of the proposed additional filter beds provides for the connection of the underdrains with the existing main underdrain along the northerly side of the beds in manholes, in which provision is to be made for the collection of samples of the effluent of the proposed new beds. It will not be practicable, however, with the existing arrangement of the underdrains to determine very definitely the character of the effluent from different portions of the present filtration area, and it is important, in the opinion of the Board, to re-arrange the outlets of the existing underdrains in such a manner that separate samples of the effluent can be obtained from the underdrains of each of the four groups of the present filter beds which drain into the main underdrain; that is, it is desirable to make such changes in the main underdrain that a sample of the effluent of beds Nos. 3, 7, 11 and 15 or 1, 5, 9 and 13, for example, can be obtained separately from the effluent of the other groups. With this arrangement the work of each group of filter beds and if necessary of each filter can be determined.

The Board further recommends that no sewage be applied to the new filters until the efficiency of the works for removing fats from the wool scouring waste has been definitely determined and the condition of the sewage after the admission of this waste has been found to be such that it will not be likely to interfere with the proper operation of the new filters.

Oct. 14, 1909.

To the Public Works Commission of the Town of Hudson.

Gentlemen: — In response to the request of your board and of the special committee of the town, received Aug. 13, 1909, for an examination of the sewage filters of the town of Hudson, to determine their condition and the extent to which each had been clogged by the excessive quantity of fats discharged upon them within the past year, and as to the best method of restoring these filters to a condition suitable for the proper purification of sewage, the Board has caused the filter beds to be examined and samples of the soil collected at various depths in fifteen of the sixteen beds to be analyzed. Filter bed No. 8 has not thus far been accessible for examination at the times the area has been visited.

The results of the examination show in general that fatty matter is present in excessive quantity in the surface layers of all of the filter beds with the exception of Nos. 2 and 16. In beds Nos. 1, 3, 4, 7, 9 and 10 the excess of fatty matter is greatest in the first 3 inches and it is probable that by the removal of about 3 inches of surface soil from these

filters, they can with proper treatment be brought into satisfactory condition. In beds Nos. 11, 12, 14 and 15 the soil for a depth of 6 inches has been quite thoroughly mixed and fatty matters were found in excess to that depth in these filters. It will be necessary, in the opinion of the Board, to remove at least 6 inches from each of these filters to restore them to a satisfactory condition. In bed No. 13, judging from a single test pit, there is a layer of coarse gravel about 2 feet in depth overlying fine sand, and this bed appears to be badly clogged at the junction of the coarse and fine material. When the fatty matter, which apparently extends to a depth of at least 6 inches in this bed, is removed, it will be essential to break up the stratification at the junction of the coarse and fine material. In bed No. 14 the depth of fatty material appears to vary considerably, and while in part of the bed it does not apparently extend to a greater depth than 3 inches, in another part the fats were found in excessive quantity at a depth of 9 inches. In bed No. 5 fatty matters were present in excessive quantity to a depth of a foot, and it will be necessary to remove at least that quantity of material from this bed.

The Board recommends that the clogged soil be removed from all of the beds to the depth herein stated. It will be essential, in order that this work may be done properly, that it be carried out under the direction of an expert, since it will doubtless be found that there is considerable variation in the depth to which the excessive quantity of fat has penetrated in the different beds, and it is very important that all of the material seriously clogged by fat be removed. After the removal of the soil containing excessive quantities of fatty matters, it should be replaced by clean sand or gravel suitable for filtration, and care should be exercised in placing this material in the beds to mix it carefully at the point of contact with the old material, in order to avoid producing stratification. It will be advantageous in restoring the material to the beds, after the removal of the clogged sand, to use material as fine as or finer than the material of which the beds are composed.

Oct. 14, 1909.

To the Public Works Commission, Hudson, Mass.

Gentlemen: — The State Board of Health received from you on Sept. 27, 1909, an application requesting advice as to the quality of the wastes which may reasonably be admitted to the sewers from the works of the Hudson Worsted Company, and in response to this request the Board has caused the works to be examined and samples of the effluent to be analyzed.

At the present time the manufacturing waste from the works of the Hudson Worsted Company consists of wool-scouring liquor, the quantity

of which has been estimated to be 25,000 gallons per day. This waste is collected first in two large tanks, in which it is treated with acid and clay, to effect the separation and deposition of the fatty matters present, after which the waste liquor is discharged upon four filters, constructed of coarse cinders 2 feet in depth, the effluent from which it is proposed to discharge into the sewerage system of the town. The deposits of sludge resulting from the treatment in the tanks are discharged upon sludge beds, of which there are six, having an aggregate area of about 900 square feet. The sludge beds are constructed of sand and cinders 2 feet in depth, and the underdrains are also designed to discharge into the town sewers.

Recent analyses of the wastes before treatment and after passing through the tanks and filters show that the effluent of the filter beds at this time was alkaline and that the quantity of fatty matters present amounted to a little over 50 parts per 100,000, the effluent of the sludge beds containing apparently a much larger quantity of fatty matter than the effluent of the filter beds.

It appears to the Board necessary to remove a greater quantity of the fats from these wastes than was being removed at the time the examination was made. It is probable that this can be done by adding a greater quantity of acid than was being used at the time of examination and collection of the samples. The Board is of the opinion that if the quantity of fats in these wastes shall be reduced to 25 parts per 100,000 they can reasonably be admitted to the town sewers. Furthermore, if in the process an excess of acid is used, its presence in the effluent of the works is unlikely to cause difficulty in the operation of the filter beds in this case, so long as it does not at any time exceed 100 parts per 100,000 and the effluent of the works does not exceed 150,000 to 200,000 gallons per week. The determination of acidity should be made with the use of methyl-orange as an indicator.

Lancaster (Lyman and Industrial Schools).

March 4, 1909.

To the Board of Health of the Town of Lancaster.

Gentlemen: — In response to your request, the State Board of Health has examined the sewage disposal system of the Industrial School at Lancaster and has recommended the construction of suitable filter beds for the purification of all of the sewage of that institution. A copy of that communication is enclosed herewith.

MARCH 4, 1909.

To the Board of Trustees of the Lyman and Industrial Schools, Lancaster, Mass., MRS. ELIZABETH G. EVANS, *Secretary.*

LADIES AND GENTLEMEN: — The State Board of Health finds as a result of observations of the disposal of sewage at the Industrial School for Girls at Lancaster that the present filtration area is inadequate for the purification of the sewage and that in order to remove the local nuisance now existing about the sewer outlet and prevent the further pollution of the neighboring brook and the Nashua River it will be necessary to provide a more efficient system of purification works.

The plans prepared by your engineer, Mr. J. J. VanValkenburgh of South Framingham and presented to this Board about two years ago, provided for filter beds of adequate capacity for the purification of all of the sewage of the school. If it is deemed desirable for any reason to make changes in the plans, the Board will give the matter further consideration if you so request.

The Board recommends that adequate works for the purification of the sewage be constructed without delay.

LENOX.

DEC. 2, 1909.

To the Board of Selectmen of the Town of Lenox.

GENTLEMEN: — The State Board of Health received from you on November 1, through your engineer, Mr. William S. Johnson of Boston, an application for advice with reference to proposed plans for improving your system of sewerage and sewage disposal, accompanied by a report of your engineer describing the present conditions of the sewerage works of the town and the plans proposed for their improvement. These plans are summarized in the report as follows: —

1. Replace about two miles of the present sewers on the west side of the town with cast-iron pipe, selecting those places where the leakage is excessive as determined by a careful inspection of the manholes during times of storms.
2. Extend the main sewer from the end of the present sewer to a point on the easterly side of the ridge east of the Housatonic River in Lee.
3. Construct a settling tank having a capacity of 20,000 gallons.
4. Construct five acres of filter beds, properly underdrained, and ¼ of an acre of sludge beds.

The Board has caused the locality to be examined by its engineer and has carefully considered the plans presented and the information available as to the condition of the present system.

The filters and irrigation area now in use for the purification of the

sewage of the town of Lenox are, in the opinion of the Board, inadequate for the purpose. Very little of the sewage is purified upon the filter beds or the irrigation area, and a very large proportion of it is discharged at nearly all times directly into the Housatonic River without treatment.

The plan proposed by your engineer for improving the method of sewage disposal provides for extending the main sewer from the present filter beds across the Housatonic River to a point in the town of Lee east of the high gravel ridge, which borders the easterly bank of the river south of Lenox station, and for purifying it there by intermittent filtration.

The area which it is proposed to use is well situated for the purpose, and, while the soil upon parts of this area is not suitable for sewage purification, your investigations show that gravel and sand of excellent quality for this purpose can be obtained from the gravel ridges which border it.

The attention of the Board has also been called to another area of land also situated in the town of Lee east of the Housatonic River, and about a mile due south of the area already described. An examination of this area indicates that it is so located that its use as a place of sewage disposal should not be objectionable, and the soil upon this area, judging from surface indications, is suitable for the purification of sewage by intermittent filtration. This area is located at a somewhat greater distance from the end of your present main sewer than the more northerly area described above, and the cost of conveying the sewage to it would be somewhat greater. The difference, however, is not likely to be large and may be offset to a considerable extent by a smaller expense for the preparation of filters and by the shorter length of pipe required to dispose of the sewage of Lenox Dale when sewers shall be constructed in that village. It is desirable that a further investigation be made of this area, and the practicability of its use as a place of sewage disposal for Lenox determined, before the location of the disposal works is finally selected.

It is evident, from measurements of the quantity of sewage flowing in the Lenox sewers, that a great quantity of water finds its way into them and causes considerable interference with the operation of the sewers and disposal works. Your engineer recommends certain measures for the prevention of leakage, and it is very important, in the opinion of the Board, that such measures be taken as will effect a large reduction in the quantity of surface water and ground drainage which now finds its way into the sewers.

By restricting leakage into the sewers all of the sewage of the town can, in the opinion of the Board, be purified efficiently upon an area of

filter beds of the size proposed if proper engineering supervision is continued in the design and construction of the works.

In the opinion of the Board, the plan presented is in general a practicable and satisfactory one for improving the system of sewerage and sewage disposal of the town of Lenox, and either of the locations suggested for the disposal of the sewage is likely to be satisfactory for the purpose. The Board recommends that the construction of the system be begun as soon as practicable.

Maynard (American Woolen Company).

To the American Woolen Company, Maynard, Mass. Dec. 2, 1909.

Gentlemen: — The State Board of Health received from you on Nov. 1, 1909, through your engineer, an application for advice as to a proposed plan of enlarging the area of filters used for the purification of the sewage from the dwelling houses located in the neighborhood of your mills at Maynard.

The plans provide for the construction of seven filter beds having an aggregate area of about .7 of an acre, which are to be located about 300 feet east of your present filter beds, and will increase the total area of the filters to about one acre. The soil in this locality, as shown by test pits, is for the most part coarse and porous and suitable for the purification of sewage by intermittent filtration. It contains, however, some fine material, the most objectionable of which it is understood is to be removed in the construction of the beds.

The plans provide for underdrains beneath the filters at depths of 4 or 5 feet beneath the surface and for the disposal of the effluent by discharging it upon the ground south of the filters, where it will find its way into a tributary of the Assabet River, which discharges into the river several miles below Maynard.

The Board, having caused the locality to be examined by its engineer and having considered the plans and information presented therewith, is of the opinion that the plan in general is a satisfactory one for enlarging the area of filter beds and providing for the purification of all of the sewage collected from the district in Maynard which your sewerage system is designed to serve.

It is essential that the improvement in the care of the beds noticeable during the last year be maintained, and that the sewage be applied to the filters in reasonable quantities and at proper intervals, allowing the sewage to disappear from the surface of each bed before additional sewage is applied. It is also important that the beds be cleaned at frequent intervals after drying and their surfaces kept in proper condition.

Monson.

To the Sewerage Committee of the Town of Monson. March 25, 1909.

Gentlemen: — The State Board of Health received from you on March 19 an application for advice as to a proposed system of sewerage and sewage disposal for the town of Monson, accompanied by a report and plans by your engineer, Mr. William S. Johnson of Boston, describing the proposed works.

The plan provides for collecting the sewage from the portions of the village which are in need of sewerage at the present time and for conveying it by gravity to filter beds to be located in the sparsely settled district in the valley of the brook north of the village of Monson, where it is proposed to purify the sewage by intermittent filtration and discharge the effluent into Chicopee Brook. In addition to the sewage, it is proposed to receive into the sewers the manufacturing wastes which now pollute the stream badly in the main village and to dispose of them at the purification works in connection with the sewage. The manufacturing wastes are to receive such preliminary treatment at the factories as may be necessary to remove grease and other matters which are likely to interfere with the operation of the sewers or filter beds. It is desired to postpone the building of the purification works and to discharge the untreated sewage temporarily into Chicopee Brook during the construction of the works.

The Board has caused the locality to be examined by its engineer and has examined the report and plans presented by your engineer, and finds that the proposed works are of adequate capacity to provide satisfactorily for the collection and disposal of the sewage of those portions of Monson now requiring sewerage or likely to require it for many years in the future. The works are also adequate for the removal and disposal of the objectionable manufacturing wastes which now cause the serious pollution of the stream in the main village. These wastes can probably be disposed of more efficiently in connection with the sewerage system of the town than in any other way, but it is very important that the recommendations of your engineer be carried out and that these wastes where necessary be subjected to treatment at the factories for the removal of grease and other matters which might interfere with the operation of the sewers or disposal works.

Regarding the discharge of untreated sewage directly into Chicopee Brook at the proposed location of the filter beds, the Board, after an examination of the conditions, advised you last year as follows: —

> . . . The stream is already polluted to a considerable extent by sewage and manufacturing wastes from the village, as shown by chemical analyses,

and considering the circumstances the Board is of the opinion that it is not advisable for the town to attempt to use Chicopee Brook below North Monson as a permanent outlet for its sewage. It is probable, in the opinion of the Board, that it will be permissible to discharge the sewage from the village into the stream temporarily during the construction of the works, and possibly to continue the discharge for a period of two or perhaps three years after the works are first put in operation. It is improbable that the discharge could be allowed to continue for a longer time than three years without creating objectionable conditions. . . .

The quantity of water flowing in the brook is so small that a very serious nuisance is likely to be created if any considerable quantity of sewage should be discharged untreated directly into the stream, but the Board believes that it would be permissible, as stated above, to discharge the sewage into the stream during the construction of the proposed works and until the sewage of a considerable part of the village has been collected into the system. How long such a discharge may be allowed to continue will of course depend upon the rapidity with which the system is constructed and extended. If comparatively few of the sewers are constructed in the beginning, such a discharge might not cause seriously objectionable conditions for several years, but it is unlikely that this method of disposal can be allowed to continue for more than three years after the beginning of the construction of the works.

The filter beds for the disposal of the sewage are to be constructed on the low land in the valley of the brook north of the village of North Monson, using for the purpose the coarse sandy soil found in the adjacent hillsides. The location is a satisfactory one from a sanitary point of view and the soil available for the filter beds is excellent for the purpose. The area of filter beds which it is proposed to construct in the beginning should be sufficient for the requirements of the town in the first few years and it is practicable to extend the area of filter beds as may become necessary in the future.

The plan as a whole is, in the opinion of the Board, an appropriate one for the collection and disposal of the sewage of Monson, and the Board recommends its adoption with the understanding that the sewage may be discharged temporarily into Chicopee Brook but only during the construction of the system and for a period not exceeding three years. The recommendations herein contained are made upon the assumption that the works are to be constructed in the near future. Should their construction be postponed, changes in the conditions affecting the streams in and below Monson may make necessary a modification of these recommendations.

MONSON (MASSACHUSETTS HOSPITAL FOR EPILEPTICS).

OCT. 14, 1909.

To the Trustees of the Massachusetts Hospital for Epileptics, Palmer, Mass., EVERETT FLOOD, M.D., *Superintendent.*

GENTLEMEN: — The State Board of Health received from you on Sept. 13, 1909, an application requesting its advice as to a proposed plan for enlarging the sewerage works of the hospital, accompanied by a plan and report describing the proposed works. The plan presented provides for collecting the sewage of the group of buildings known as the "Farm Group," located about 3,000 feet northwest of the main group of hospital buildings, and the sewage of the group of buildings now under construction, known as the "Children's Colony," located about 3,500 feet south of the "Farm Group" and 2,000 feet southwest of the main group of buildings, and conveying it to filter beds adjacent to those now in use on the slope of a hill not far from the southerly bank of the Quaboag River. It is also proposed to provide a by-pass or connection, by which the sewage of the main group of buildings can be intercepted above the flush tank on its way to the present filtration area and discharged into the proposed new sewer, so that the sewage from the old group of buildings can be diverted to the new filtration area if desired. A dosing and flush tank is also to be constructed on the new sewer, in order to provide for discharging the sewage intermittently upon the filter beds. It is proposed to continue the use of the small filtration area located near the highway from Palmer to Monson, now used for the disposal of the sewage of buildings Nos. 1, 2 and 3 of the "Farm Group," and to use these beds for the disposal of the sewage from buildings Nos. 3 and 4 of the "Farm Group," in which it is understood that there will be at no time more than 25 persons.

The additional area of filter beds which it is now proposed to construct will amount, according to the plans, to about one acre. The area will be divided into three filter beds, having areas respectively of .42, .24 and .32 of an acre each, and it is proposed to underdrain each of the filters with a main underdrain and laterals about 37 feet apart. The highest of these filters will be at elevation 355 and the lowest at elevation 330, as compared with 342 and 325, the respective elevations of the highest and lowest of the old filters. The filter beds will be located on the side of a hill, the soil of which, so far as can be judged from samples collected from a gravel pit in this locality, consists of fine gravel and coarse sand, well suited for the purification of sewage by intermittent filtration.

The Board has caused the locality to be examined by one of its

engineers and has considered the plans and information presented therewith. The quantity of sewage now discharged from the hospital buildings, as indicated by the amount of water used therein, is probably a little less than 70,000 gallons per day, but with the completion of the "Children's Colony" the quantity is likely to increase and may soon reach 100,000 gallons per day or possibly a somewhat larger amount.

The present filtration area, which consists of eight beds, having an aggregate area of a little less than .6 of an acre, is inadequate for the purification of all of the sewage at present discharged from the hospital buildings. These filters, which are not underdrained, have been overworked and evidently considerably clogged at the surface by the excessive quantity of sewage applied to them, but, in the opinion of the Board, with the best of care, this area would not be sufficient for the purification of all of the sewage of the hospital.

The Board is of the opinion that the plan proposed for enlarging the sewage disposal works is in general an appropriate one for the purpose, and if the filter beds are properly constructed of soil of the character found in the test pit upon the area, they will be adequate, if used in connection with the existing filters, for the present requirements of the hospital, including the buildings of the new "Children's Colony," so called, unless the quantity of sewage shall become considerably greater than there is now reason to anticipate.

It is understood that difficulty has been experienced in securing the proper maintenance of the screen at the dosing tank, and it is desired to discharge all of the sewage directly upon the filtration area. It appears to the Board, however, to be desirable to continue the use of a dosing tank, in order to secure intermittency in the operation of the filters, and the use of a screen is desirable to avoid possible difficulty in the operation of the tank.

When the old beds were constructed underdrains were omitted, since their capacity seemed likely to be adequate for the requirements of the hospital without underdrainage for several years. As soon as the new beds are completed and available for use, it will be desirable to examine carefully the old filter beds to determine their condition and whether their efficiency can be materially improved by providing underdrains.

New Bedford.

Sept. 2, 1909.

To the Hon. William J. Bullock, *Mayor, New Bedford, Mass.*

Dear Sir: — The State Board of Health received from you on Aug. 14, 1909, an application for advice as to eliminating the nuisance existing at Clark's Cove in the city of New Bedford, in which you outline two general plans which have been suggested for relief, one being the

erection of a bulk-head and the filling of the flats at the head of the cove with ashes or other material, and another the transfer of the sewage from Clark's Cove to an outlet at the foot of Cove Street, on the harbor side of the city.

A third method is also suggested for the permanent removal of the nuisances existing about the sewer outlets both along the harbor front of the city and in Clark's Cove, by constructing intercepting sewers to collect the dry-weather flow of sewage from the existing sewers and discharge it into the bay at some suitable place off Clark's Point.

You have also submitted reports of the city engineer describing the existing conditions and plans for a general system of sewage disposal for the city and have supplied the Board with plans showing the location of the various sewers and outlets.

The Board has caused the locality to be examined by its engineer and has carefully considered your application and the reports and plans presented. There can be no question as to the very serious character of the nuisance now existing at the head of Clark's Cove and the danger to the public health from the offensive deposits of sewage sludge and the gross pollution of the water along this thickly populated shore. Conditions nearly as bad exist at many places along the harbor front where the sewers of the city discharge into the docks and along the shores of the Acushnet River and New Bedford harbor. It appears to the Board of the greatest importance to the health of the city that these nuisances be removed as soon as possible and that the pollution of the shores and waters about the city be effectively and permanently relieved.

The plan of building a bulk-head across the upper end of Clark's Cove, extending the sewers beyond it and filling behind it with ashes or other material is, in the opinion of the Board, a very objectionable one. The cost of constructing the bulk-head and filling the flats would be very large, and while the filling was in progress the nuisance would probably be greater than now. The use for filling of ashes collected from the city would be highly objectionable, since such wastes usually contain much organic and other objectionable matter of various kinds and the use of such material for filling would have a tendency to make the conditions worse than they are at the present time.

Moreover, if a bulk-head should be built, as proposed, there is little doubt that conditions similar to those now existing would be reproduced outside the bulk-head. To attempt to fill the flats without constructing the bulk-head would leave the conditions practically as at present.

The best practicable plan of preventing the nuisance in Clark's Cove will be to remove the sewage therefrom to some suitable outlet in the bay.

It is very improbable that a suitable outlet can be found in Clark's Cove, since under the conditions which exist there the movement of the sewage is likely to be influenced chiefly by the winds, and the prevailing winds of summer would tend to carry sewage discharged at any point in the cove, unless possibly at its outlet, to neighboring shores.

The plan of collecting the sewage now flowing into Clark's Cove and conveying it across the narrow peninsula of Clark's Point to an outlet at the foot of Cove Street is also an objectionable one. The present sewer outlets near Cove Street cause a serious nuisance and the conditions would inevitably be made worse if the large quantity of sewage now flowing into Clark's Cove should be discharged at any point in that neighborhood.

Investigations by the city engineer show that it is practicable to collect all of the sewage of the city, including that now flowing into Clark's Cove, at some place near the southerly end of the city, and to discharge it into the bay off Clark's Point, where it will be mingled with a large volume of sea water, and there is no reason to doubt that a location can be found where the discharge of the sewage will be unlikely to cause objectionable conditions. Such a plan is, in the opinion of the Board, the best practicable method of securing effective and permanent relief from the nuisances now existing in Clark's Cove and elsewhere about the city.

The sewers of the city are built upon the combined plan and it will be impracticable to build an intercepting system of sufficient capacity to remove the entire flow in the sewers at times of heavy rain; but it will be practicable to remove all of the dry-weather flow, including a part of the flow at the beginning of storms, and thus prevent the discharge of sewage into the waters adjacent to the city at all times except during heavy rains, when it will be necessary to allow a portion of the mingled sewage and storm water to discharge at the existing outlets. The quantity of sewage that it will be necessary to dispose of in this way, however, will be small and it is unlikely to be very objectionable, at any point.

It is desirable, nevertheless, in the opinion of the Board, for the city to construct its sewers and drains in the future on the separate plan and also to separate the sewage from the storm water in the areas now served by combined sewers. Storm water, if unpolluted by sewage, can be allowed to discharge into the streams and waters about the city without danger of creating a nuisance. The city is favorably situated for carrying storm water directly into the harbor or into Clark's Cove or other tributaries by means of street gutters and comparatively short storm water drains of small size. The separation need not be very costly if

begun without delay and will in the end aid materially in the economical and efficient disposal of the sewage.

The Board recommends that the city begin as soon as practicable the construction of a general system of sewage disposal which will provide adequate means for the removal of the sewage from the present outlets both in Clark's Cove and in New Bedford harbor and the Acushnet River to some suitable outlet into the sea.

Before the construction of works adequate for the permanent relief of existing nuisances can be begun, it will be necessary to prepare detailed plans of the proposed sewers and other necessary works, and it is important also to study further the question of the most suitable outlet or outlets for the sewage. The Board recommends that if possible the city begin these investigations and the preparation of plans during the present year, in order that unnecessary delay in beginning the construction of the works may be avoided.

North Attleborough.

June 10, 1909.

To the Sewerage Committee of the Town of North Attleborough.

Gentlemen: — The State Board of Health received from you on May 1, 1909, an application, under the provisions of chapter 269 of the Acts of the year 1909, for the approval of a proposed system of sewerage and sewage disposal for the town of North Attleborough which provides for the purification of the sewage upon filter beds located in Attleborough on land lying westerly of the Attleborough Branch Railroad, so called, and between said railroad and the Ten Mile River and within a distance of 1,500 feet of the North Attleborough town line, as provided in chapter 448 of the Acts of the year 1908; and in accordance with the provisions of said chapter 269 the State Board of Health gave a hearing upon the proposed plans at its office, Room 143, State House, on May 6, 1909, after giving notice of the hearing by publishing the same in newspapers circulating in the towns of North Attleborough and Attleborough and after notice in writing to the selectmen of the town of Attleborough.

At this hearing no person appeared to object to the approval of the plans presented. After the hearing the Board voted to approve the proposed system of sewerage and sewage disposal as shown upon the plans submitted, the general plans of the system of sewers and the disposal works being shown upon four sheets bearing respectively the following titles: —

No. Attleboro Sewerage System. Plan showing Lateral and Intercepting Sewers and Location of Disposal Plant. Scale 1 Inch = 500 Feet. June 1908. F. A. Barbour, Engineer.

No. Attleboro Sewerage System. Plan showing General Arrangement of Disposal Area. Scale 1 Inch = 40 Feet. June 1908. F. A. Barbour, Eng'r.

No. Attleboro Sewerage System. Plan showing Details of Settling Basins. Scale 1/4 Inch = 1 Foot. June 1908. F. A. Barbour, Engineer.

No. Attleboro Sewerage System. Plan showing Test Pits near Attleboro Line. Scale 1 Inch = 80 Feet. June 1908. F. A. Barbour, Eng'r.

A copy of the advice of the Board relative to the proposed plans of sewerage and sewage disposal of the town of North Attleborough addressed to your committee under date of Oct. 1, 1908, containing certain recommendations as to carrying out these proposed plans, is appended hereto.

Norwood (Winslow Brothers & Smith Company).

Dec. 2, 1909.

To Winslow Brothers & Smith Company, *Norwood, Mass.*

Gentlemen: — During a period of several years experiments have been made from time to time upon the purification of the waste discharged from your tannery at Norwood into Hawes Brook, a tributary of the Neponset River. These experiments have shown that the manufacturing waste from your works can be purified satisfactorily by sedimentation and intermittent filtration through filters of sand or gravel about 5 feet in depth, operated at a rate of about 75,000 gallons per acre per day, as you have already been advised.

The experiments of the Board further show that with settling tanks properly designed and maintained, the settled refuse can be applied to trickling filters at a rate of about 1,000,000 gallons per acre per day and an effluent secured which, after further sedimentation, can be purified on sand filters at a rate about twice as great as would be the case without the use of the trickling filter. Either of these methods would, with works properly constructed and maintained, produce an effluent which would not produce a nuisance when discharged into the Neponset River.

Your present filter beds contain much fine material unsuited to the purification of sewage by intermittent filtration, as shown by analyses of samples of the filtering material. Their inability to purify large quantities of the waste is further shown by experience in their operation. In order to secure efficient results at as high a rate as practicable with sand and gravel filters, these filters will, in part at least, require reconstruction.

A part of the waste discharged from your works consists of polluted water which has been used in the scouring and rinsing of wool. The scouring waste doubtless contains considerable fat, and it is advisable that it be kept separate from the other wastes and treated for the removal

of fats, when it may then be mingled with the other wastes for final purification. The water used in rinsing the wool is still being discharged into the brook and not used for other processes in the factory, as was proposed two years ago.

The Board advises that the construction of works adequate for the proper purification of all of the waste from your factory be begun without further delay. They should be designed and constructed under the supervision of an engineer of experience in matters relating to sewage disposal, and the engineer and chemist of the Board will furnish your engineer with such information as they have collected relative to the disposal and purification of wastes such as those discharged from your factory.

Palmer.

March 24, 1909.

To the Sewerage Committee of the Town of Palmer, Mr. George E. Clough, *Chairman.*

Gentlemen: — The State Board of Health received from you on March 3, 1909, the following application for advice as to a proposed system of sewers for the northerly part of the village of Palmer: —

> The committee appointed at the last annual meeting of the town of Palmer and instructed to procure a plan for a system of sewers for the North part of the Depot Village of Palmer submit a plan for your approval. According to the plans and specifications it is our intention to have the sewer take care of house sewage and surface water. We therefore respectfully request that your honorable Board will act upon this matter at as early a date as possible to enable the committee to report at our next annual town meeting in March.

The plan submitted provides for the collection of the sewage and storm water from the northwestern part of the village of Palmer and discharging it into the Quaboag River at two outlets, one to be located about 1,000 feet below the point where the river is crossed by the Boston & Albany Railroad, and the other about 3,500 feet farther down stream, following the course of the river, and about 1,000 feet from the Wilbraham Road bridge. It is understood that it is proposed to begin the construction of the sewers which will discharge at the easterly outlet during the present year and that the construction of the sewers which will discharge at the westerly outlet will be postponed to a later time. The sewage is to be discharged directly into the river at all times without purification.

The Board has caused the locality to be examined by one of its engineers and has examined the plans presented and the records of exam-

inations as to the effect of the discharge of sewage into the Quaboag River from the sewer outlets constructed in previous years.

Plans for a system of sewerage for the village of Palmer were first considered by the Board in 1892. The plans then submitted provided for the construction of a separate system of sewers with an outlet into the Quaboag River just below the Boston & Albany Railroad bridge, and after giving a public hearing on the question of the disposal of the sewage, the Board on Feb. 1, 1894, gave the following advice to the town of Palmer: —

. . . As a result of investigations by the engineer of the Board, and a careful consideration of the plan proposed by you and the statements presented at the hearing, the Board concludes that the adoption of a system of sewers from which storm water is excluded is to be commended as being the best adapted to the present and future requirements of the main village of Palmer, and that the sewage may be turned into the Quaboag River below the Boston & Albany Railroad bridge, as proposed, for the present, with the understanding that the sewage is to be diverted from the river and purified whenever the pollution of the stream makes such action necessary. . . .

The system constructed under the above recommendation "with the understanding that the sewage is to be diverted from the river and purified whenever the pollution of the stream makes such action necessary," has now been in existence for nearly fifteen years and recent examinations of the condition of the sewer outlets and the river below them do not show that the condition of the river has as yet become seriously objectionable in the neighborhood of the town of Palmer by reason of sewage pollution. Under the circumstances the Board is of the opinion that the disposal of the sewage of the town of Palmer by discharging it into the Quaboag River can reasonably be continued for the present.

In the communication quoted above the Board stated that the adoption of the separate system of sewers, excluding storm water, was to be commended as best adapted to the present and future requirements of the main village of Palmer, but the Board is informed that storm water has been admitted to the sewers at many points since their construction and the plan for extensions now submitted proposes the use of the combined system of sewers.

After a careful consideration of the plans and the circumstances affecting the collection and disposal of the sewage the Board is of the opinion that it is of the greatest importance for the town of Palmer to adhere strictly to the separate system in the maintenance and extension of its sewers, since otherwise the town is likely to be involved in a large and

unnecessary expense for separating the sewage from the storm water when the purification of the sewage becomes necessary.

Under the circumstances the Board does not recommend the adoption of the plan now proposed but recommends instead that the sewers be constructed strictly upon the separate plan and that all storm water and ground drainage be excluded from them so far as practicable. If it is necessary to lower the level of the ground water in the areas in question and remove surface drainage, separate conduits should be provided and used strictly for that purpose. If the separate system of sewers is adopted for the disposal of the sewage of the areas in question, the sizes of the sewers can be reduced considerably from those shown upon the plan presented.

The Board sees no serious objection, however, to the temporary connection of both the sewers and the storm water drains into the proposed new main outfall sewer, leading from North Main Street to the river, in the easterly part of the district shown upon the plan now submitted, since a saving in expense can possibly be made by making this conduit large enough to receive both the sewage and storm water at the present time, and it will not be difficult to divert either the sewers or storm water drains from this sewer when separation becomes necessary, if the systems are kept separate elsewhere. The storm water drains can be discharged into local waters at any convenient point without objection, provided sewage is kept out of them.

Quincy.

Nov. 11, 1909.

To Mr. Randolph Bainbridge, *Commissioner of Public Works, Quincy, Mass.*

Dear Sir: — The State Board of Health received from you on Sept. 27, 1909, the following application for the approval of a plan of a proposed system of sewerage for the districts of Hough's Neck and Germantown in the city of Quincy: —

In accordance with the provisions of chapter 279, Acts of 1895, I submit to you for your approval, plan showing proposed Sewerage System for Hough's Neck and Germantown, Quincy, Mass.

Such additional information as you may desire will be furnished you by the city engineer.

The application was accompanied by a plan showing the location of the proposed sewers and pumping stations by means of which it is proposed to collect eventually all of the sewage of these areas and dispose of it by discharging it into the high level sewer of the south metropolitan

sewerage district. By this plan the sewage of three small districts near the easterly end of the Hough's Neck peninsula will be disposed of into the metropolitan sewer by gravity, while the sewage from the remaining areas is to be collected at two pumping stations, one located near Island Avenue in the extreme easterly part of the district, and the other near Lee Street in the westerly part of the district, from which the sewage will be pumped to the metropolitan sewer.

The Board has caused the locality to be examined by one of its engineers and has carefully considered the plan presented.

While large portions of these districts are sparsely populated, there are other areas in which the growth of population has been rapid and a system of sewerage has become necessary. The best method of disposing of the sewage of this district is to discharge it into the metropolitan sewerage system, and the Board approves the plan presented as a reasonable method of collecting and disposing of the sewage of the districts of Hough's Neck and Germantown.

Revere (Revere Beach).

July 1, 1909.

To the Board of Health of the Town of Revere, Mr. Eugene J. Wallace, *Secretary.*

Gentlemen: — In response to your request of June 15 for an examination of the sanitary conditions at the northerly end of Revere Beach between Revere Street and the Point of Pines, with special reference to the present method of sewage disposal in this section, the Board has caused the locality to be examined by its engineer and has considered the information as to the present conditions in this region and the best practicable method of improving them.

Most of the buildings in question are situated at the edge of the former salt marsh back of Revere Beach and adjacent to the right of way of the Boston, Revere Beach & Lynn Railroad. Only the portion within about three-fourths of a mile north of Revere Street is very densely populated and this section contains about 100 cottages and tents, including two hotels, a city mission and other buildings. The cottages are crowded very closely together and the sewage from them is disposed of into cesspools and other receptacles, which are necessarily located very close to the cottages.

The salt marsh at the edge of which these buildings are situated was formerly covered by salt water at high tides, but the flooding of these lands by the tide has been prevented by the construction of a tidegate near the Eastern Division of the Boston & Maine Railroad, and the surface drainage is carried off by a ditch in the rear of the buildings,

which discharges through the tide-gate into the Pines River. The soil about the houses, however, is evidently saturated with water very close to the surface of the ground, and water stands in the ditch and in places upon the surface of the ground even in dry weather. At the time of the recent examinations sewage in considerable quantity was evidently finding its way into the ditch, the water of which was very offensive.

On account of the lack of proper means of sewage disposal the conditions about these cottages are extremely objectionable and unsanitary and, in the opinion of the Board, are a great menace to the health of the region. The character of the soil is very unfavorable for the disposal of sewage by means of cesspools, and the only practicable plan of providing efficiently for the sewerage of this district would be to construct a sewer to receive and remove the sewage to some proper place of disposal.

The Board is informed that a branch sewer of the sewerage system of the town of Revere has been constructed to a point within about 250 feet south of Revere Street and that it is practicable to extend this sewer so as to provide for the entire sewerage of Revere Beach to its northerly limit. It is not a matter of serious difficulty or expense to extend this main sewer to serve the thickly populated district north of Revere Street, and the Board recommends the extension of this sewer as soon as possible as the best plan for relieving the objectionable conditions in that district. When a sewer has been provided it will be essential to abolish all cesspools and other receptacles for sewage and require that all sewage be discharged into the sewer.

After the sewage has been removed it is probable that water will not stand upon the ground about the buildings or in the ditches, at least in the drier portion of the year; but if objectionable conditions, due to standing water, still remain after the sewer has been constructed, suitable and adequate drainage should be provided.

It is very desirable also, in the opinion of the Board, that a reasonable minimum grade for cellars and fixtures in this region be established and strictly enforced, in order that these rapidly growing areas may be provided with proper sewerage and drainage without excessive cost.

The Board recommends that the extension of the main sewer to the section in question be made as soon as possible, and that as soon as it is available, the use of cesspools and other receptacles for sewage be discontinued without delay.

RUTLAND (STATE SANATORIUM).

MAY 6, 1909.

To the Board of Trustees of the State Sanatorium, Rutland, Mass.

GENTLEMEN: — In response to your request for a further examination of the sewage disposal system at the sanatorium at Rutland and advice as to the construction of an additional area of filters, amounting to about .36 of an acre, which, with the filters already constructed, would make the total filtration area about 1.4 acres, the Board has caused a further examination of the locality to be made by one of its engineers and has caused observations to be made of the flow of sewage at various points between the institution and the present filtration area.

These observations were made on March 23 and April 16, the former in a comparatively dry period at a time when the ground was frozen and no rain had fallen for several days, and the latter on the day following a very heavy rain.

The sewage from the buildings is collected into a flush tank, which discharges automatically several times during the day, and on each of the days when observations of the flow were made the quantity of sewage entering the sewer from the institution was found to be between 60,000 and 65,000 gallons per day. The quantity of sewage discharged at the filtration area, on the other hand, when no sewage was being discharged from the flush tank, was found to be on March 23, 12,000 gallons per day, and that quantity evidently represents the amount of ground water entering the main sewer at that time between the flush tank and the filtration area. At the time of the observations made in April the quantity of water flowing in the sewer at the manhole 1,900 feet above the upper end of the inverted siphon, when no sewage was passing the flush tank, was between 8,000 and 9,000 gallons per twenty-four hours, and this quantity probably represents the leakage into the portion of the sewer between the flush tank and this manhole at the time when the leakage is greatest. At the next manhole further down the sewer and about 1,300 feet above the head of the siphon the flow had increased to 56,300 gallons per twenty-four hours, when no sewage was passing the flush tank, and at the filtration area the flow at that time was at a rate of a little over 100,000 gallons per twenty-four hours.

The sewer throughout most of the 1,900 feet next above the inverted siphon is laid through wet and marshy land, and the great quantity of ground water leaking into the sewer evidently enters it through the joints of the pipes and the interstices of the brickwork, of which the manholes are constructed.

The filter beds now in use have an area of approximately one acre,

and with the additional filter beds which it is now proposed to construct the total area would be about 1.4 acres. In the opinion of the Board, this area would be entirely inadequate to purify properly all of the sewage of the institution, increased, as it now is, by the great quantity of leakage which finds its way into the main sewer at times of wet weather.

The only practicable plan of preventing this excessive leakage is to reconstruct the main sewer throughout the 1,900 feet above the upper end of the inverted siphon, using iron pipe with lead joints in place of the ordinary sewer pipe now in use, and to reconstruct the manholes on this portion of the sewer and make them water-tight. When the leakage has been eliminated, the quantity of sewage to be disposed of, including leakage, will apparently be about 70,000 gallons per day. This quantity is somewhat larger than was indicated in the investigations of last year, and in order to purify it properly at all times, it will be advisable, in the opinion of the Board, to construct the additional filter beds now proposed. With this additional area the filters will be capable of purifying all of the sewage of the institution until the quantity has increased considerably beyond the amount now being discharged therefrom.

The area of land in the neighborhood of your present filter beds containing soil well suited to the purification of sewage is very limited and it is desirable to reduce the quantity of sewage to be disposed of to the smallest practicable amount.

The Board recommends that the construction of the additional filter beds and the reconstruction of the main sewer, including the manholes therein, for a distance of 1,900 feet above the inverted siphon be carried out as soon as the weather conditions become favorable for this work.

Templeton (Templeton Inn).

Feb. 4, 1909.

To Mr. Percival Blodgett, *Templeton, Mass.*

Dear Sir: — The State Board of Health has considered your application of December 10, received through your engineer, Mr. W. W. Locke, for advice as to a proposed sewer and filter beds for the removal and disposal of the sewage of the Templeton Inn and a dwelling house near by, and has examined the plan presented therewith.

The plan provides for conveying the sewage by gravity from the Inn through a 6-inch pipe 1,650 feet in length, to be located for a portion of the distance in the Wellington road but for the most part in private lands, to four filter beds, to be located about 800 feet southwest of the Wellington road and 900 feet from the nearest dwelling house. The

proposed filter beds are to be four in number, each 70 by 80 feet, with a depth of filtering material of about 4 feet. They are to be underdrained by a main underdrain 8 inches in diameter and two tributary underdrains 6 inches in diameter, and provision is made whereby two other beds of similar size can be added to the works in the future if necessary.

The filter beds will be remote from dwelling houses and the location is a satisfactory one. Some of the material which it will be necessary to use in the construction of the filters is finer than desirable, but with proper care in their construction and operation it is likely, in the opinion of the Board, that the filters will purify the sewage from the Inn and dwelling house satisfactorily at all times.

The Board recommends that the plan now proposed be adopted and that the further use of the present disposal area be discontinued.

Westborough.

June 3, 1909.

To the Sewer Commissioners of the Town of Westborough.

Gentlemen: — In accordance with your request the State Board of Health has investigated the character of the waste discharged from the works of the yeast company in Westborough and its effect on the operation of the filters used for the purification of sewage.

The waste discharged into the sewers from this factory is of two kinds: the waste from the still used in distilling the liquid in which the yeast is grown (which is used for the purpose of making white wine vinegar), and the waste from the washing of the yeast, the total volume of these wastes amounting to about 12,000 gallons per day. The concentrate from the still, amounting to 3,000 to 4,000 gallons per day, is passed into the sewers generally at a high temperature and all of the waste from the factory is discharged into the sewers within a comparatively short time. The wastes from both of these processes are of a very stable character and are very difficult to purify by filtration, but experiments upon their treatment show that, when mixed with sewage in the proportion of not over 7 per cent. waste to 93 per cent. sewage, the mixture can be purified on ordinary sand filters and an effluent obtained that may safely be discharged into the Assabet River. It is important, however, to remove as much as possible of the suspended matter from the wastes before discharging them into the sewers.

The Board recommends that the wastes from the yeast factory be passed first through settling tanks and then that provision be made whereby the waste may flow in a small but quite uniform stream into the sewer and then pass to the filtration area after being mixed evenly through the sewage throughout the twenty-four hours. If the settling

tanks are made of sufficient size and operated satisfactorily, it is probable that the sewage containing this waste can be purified by intermittent filtration without serious difficulty, but it may possibly be found necessary to remove a greater portion of the organic matter from the wastes than will be removed by sedimentation alone, and in that case it will be necessary to construct a strainer of coke or sand at the factory, through which the wastes can be strained before entering the sewer. The strainer should contain a depth of as much as one foot of sand or coke above a suitable system of underdrains to maintain the material in place, and should have an area of as much as 2,000 feet for the treatment of the 12,000 gallons at present discharged from the factory.

AUG. 12, 1909.

To the Sewerage Committee of the Town of Westborough.

GENTLEMEN: — The State Board of Health received from you on July 16, 1909, an application for advice as to a proposed plan of increasing the area and the efficiency of the filter beds used for the purification of the sewage of the town of Westborough, accompanied by a report by your engineer describing the condition of the present sewerage system and disposal works and the plan of improvement recommended.

From the engineer's report it appears that an examination of the main sewer leading from the town to the filtration area shows that it is in very poor condition throughout much of its length and that water leaks into it through the manholes and through leaky joints in the pipes. Part of this sewer was taken up several years ago and relaid with iron pipes with lead joints, but the manholes in this portion still admit a large quantity of water. It is deemed practicable to prevent a considerable portion of this leakage without serious trouble or expense and thus reduce materially the quantity of sewage to be purified upon the filtration area.

It further appears from the report of your engineer that the quantity of sewage requiring purification is also largely and unnecessarily increased by the admission of surface water, there being at least three catch basins and a drain from one of the schoolhouses from which surface water is now discharged into the sewerage system.

The plan now presented provides for the construction of four additional filter beds having a combined area of about two acres, which would increase the total area of the filters to about six acres. The new filters are to be constructed of soil taken from the adjacent highlands where material of very good quality for the purpose can be found. It is proposed to change the location of the screen house so as to place it at a higher elevation, and to make certain changes in the distributing system so that the sewage can be applied to the filter beds more rapidly than

at the present time. It is also proposed to relocate the sludge bed and to separate some of the larger filter beds into smaller ones by changing the location of the embankments between the beds.

The Board has caused the locality to be examined by its engineer and has considered your application and the plans and information submitted therewith. It is very important, in the opinion of the Board, to reduce the quantity of sewage to be disposed of at the filtration area by eliminating as much of the leakage into the main sewer as practicable, and it is essential that all connections through which surface water is now admitted to the sewers be immediately cut off as recommended by your engineer, and that care be taken in future to prevent further connections of that sort.

The quantity of sewage discharged upon the Westborough filtration area averages under the present conditions about 300,000 gallons per day during the six months from January to June, inclusive, and for the three maximum months of this period is probably nearly 400,000 gallons per day. This quantity is larger than the filter beds are capable of purifying satisfactorily at all times. Moreover, the strength of the sewage has been greatly increased by the admission of the wastes from the yeast factory, and it is necessary to enlarge the filters in order to provide adequately for the purification of the sewage.

By reducing the quantity of sewage as proposed by your engineer and enlarging the filter beds by the construction of four additional filters as proposed on the plans presented, the filtration area should be adequate for the purification of the sewage at present discharged from the town, and the plan is, in the opinion of the Board, an appropriate one for enlarging your sewage disposal works. The proposed change in the location of the screen house is a desirable one to adopt, and it is important to enlarge the means of discharging sewage upon each of the filter beds as proposed.

It is important that the outlets of the underdrains be so constructed that it will be practicable to obtain without difficulty samples of the effluent from each of the principal underdrains shown upon the plans. Success in the operation of the filter beds will depend largely upon the care with which the works are constructed, and competent engineering supervision should be continued until the works are completed.

You have also submitted a plan for a settling tank for the purification of the manufacturing wastes discharged into the sewers from the yeast factory, concerning which you were advised in a communication under date of June 3, 1909. A further examination of these wastes indicates that the quantity is somewhat greater than was found to be the case at the time the previous examination was made, and the Board is in-

formed that the works are likely soon to be enlarged. Under the circumstances the Board will give the matter further consideration and advise you concerning the treatment of these wastes as soon as practicable. It is not necessary, however, that the construction of the filter beds should be delayed to await the results of the further investigations as to the disposal of the factory wastes, and the Board recommends that the construction of the new filter beds be begun at once.

To the Sewer Commissioners of the Town of Westborough. SEPT. 15, 1909.

GENTLEMEN: — In response to your communication of July 16, 1909, relative to the wastes from the Hickey-Riedeman Yeast Company, the State Board of Health has examined the plan of a settling tank for the treatment of the wastes from this factory and has made further investigations concerning the character and amount of the wastes and the methods necessary for the purification thereof. The results of these investigations confirm the preliminary investigations made earlier in the year, when the Board made the following recommendation relative to the treatment of the wastes from this factory: —

> The Board recommends that the wastes from the yeast factory be passed first through settling tanks and then that provision be made whereby the waste may flow in a small but quite uniform stream into the sewer and then pass to the filtration area after being mixed evenly through the sewage throughout the twenty-four hours. If the settling tanks are made of sufficient size and operated satisfactorily, it is probable that the sewage containing this waste can be purified by intermittent filtration without serious difficulty, but it may possibly be found necessary to remove a greater portion of the organic matter from the wastes than will be removed by sedimentation alone, and in that case it will be necessary to construct a strainer of coke or sand at the factory, through which the wastes can be strained before entering the sewer. The strainer should contain a depth of as much as one foot of sand or coke above a suitable system of underdrains to maintain the material in place, and should have an area of as much as 2,000 feet for the treatment of the 12,000 gallons at present discharged from the factory.

The further investigations show that the quantity of waste is somewhat greater than indicated by the observations made up to that time, but there is a considerable difference between the records of meter readings showing the quantity of water used in this factory and the measurements of the quantity of wastes therefrom. It is evident, however, that the quantity of waste varies somewhat from time to time and may amount to as much as 16,000 gallons per day, most of which is of a character very difficult to purify by the methods employed in the treatment of sewage.

With a quantity of waste amounting to no more than the quantity now discharged from the factory, it is probable that by passing this waste through a settling tank and subsequently discharging it into the sewers in such a manner that the flow will be distributed throughout the greater part of the twenty-four hours, the operation of the filter beds will not be seriously interfered with.

The tank shown in the plan submitted is of sufficient capacity for present requirements, and it should be practicable, by throttling the valve at the outlet, to distribute the flow of the waste into the sewers quite evenly throughout the twenty-four hours. It is desirable, however, to set this tank at a considerably higher level and to provide some place on which to empty the contents of the sludge pit and allow them to be dried before being removed.

In view of the possible necessity of providing further purification for these wastes before they are admitted to the sewers, it is important that in designing the works the tank be located at such a place and at such an elevation that the effluent therefrom can be filtered and subsequently delivered to the sewer in the most economical way. It is desirable, under the circumstances, that all of the work suggested be properly designed in the beginning. The settling tank can then be built and the effect of its use observed, and if subsequent filtration is necessary before the wastes are delivered to the sewers, the filters can be added without material changes in the works. The experiments of the Board indicate that it will be necessary to provide further treatment for these wastes than will be obtained by the use of the settling tank alone, if the amount of wastes from the factory shall be increased materially above the quantity which was being discharged there at the time the recent measurements were made. The Board recommends that the tank be constructed and placed in operation as soon as practicable. Competent engineering supervision should be continued in the further design and construction of these works.

Westborough (Hickey-Riedeman Yeast Company).

Nov. 4, 1909.

To the Hickey-Riedeman Yeast Company, Westborough, Mass.

Gentlemen: — Acting under the authority of chapter 433 of the Acts of the year 1909 the State Board of Health has investigated the operation of the sewage disposal system of the town of Westborough, and finds that it is operating unsatisfactorily and that the effluent therefrom creates a nuisance in the Assabet River below the disposal works. The Board also finds that the unsatisfactory operation of the system is due in large part to the discharge into the sewers of the waste liquors resulting from the manufacture of yeast in your establishment, which

contains alcohol and particles of yeast in suspension, and the Board hereby requires the treatment of all of the wastes from this factory in such manner as may be necessary to remove the alcohol and yeast therefrom; and further requires that the discharge of these waste liquors, after treatment, into the sewers shall be regulated in such manner as shall cause them to flow into the sewer at an approximately equal rate throughout the twenty-four hours of the day.

Miscellaneous.

The following is the substance of the action of the Board during the year in reply to applications for advice relative to miscellaneous matters: —

Adams.

Dec. 2, 1909.

To the Board of Selectmen of the Town of Adams.

Gentlemen: — Complaint has been made to this Board of the objectionable condition of the Hoosick River, and examinations made by the Board show that the river is very badly polluted by sewage and manufacturing waste, a part of which is contributed by the town of Adams.

The Board recommends that the construction of sewers for the collection and proper disposal of the sewage of Adams — plans for which were prepared recently — be begun during the coming year. There are several serious nuisances within the limits of the town of Adams caused by the discharge of sewage into small tributaries of the Hoosick River. It is very important, both to the health of the town of Adams and of the inhabitants in the valley of the Hoosick River below, that the construction of sewerage works should be begun in the coming year and carried out diligently until the serious pollution of the Hoosick River, either by sewage or by objectionable manufacturing wastes within the town, has been prevented.

Amesbury.

March 4, 1909.

To the Board of Health of the Town of Amesbury.

Gentlemen: — Complaint has been made to this Board that the flats and waters of the Powow River in the neighborhood of the Amesbury and Salisbury Gas Light Company's works are being badly polluted by refuse coal tar and oils, to the great annoyance of those living in the neighborhood and using the river for boating and other purposes, and in response to that complaint the Board has caused the locality to be examined by one of its engineers.

The results of the examination show that a stream of waste liquor, containing ammonia, tar and oil, is discharged from the gas works upon

the bank of the river a few feet above high tide and that this waste flows over the flats in the neighborhood and causes a very serious nuisance. Wastes from such works can be treated, and are now being treated at the Lowell Gas Works, in such a way that they can be discharged into the river through a properly located outlet below the level of low water without causing objectionable conditions.

It is important, in the opinion of the Board, that a proper method of treatment for these wastes be provided without delay, in order to prevent the serious nuisance now resulting therefrom before the coming of another summer.

Brockton (Brockton Gas Light Company).

Dec. 2, 1909.

To the Brockton Gas Light Company, Brockton, Mass.

Gentlemen: — Complaint has been made to this Board of a nuisance in the Matfield, or Salisbury Plain, River in the town of East Bridgewater, caused by the discharge into the stream of polluting substances beyond the limits of that town, and in response to this application the Board has caused an examination of the river to be made and samples of water collected at numerous points along the course of the river and its tributaries to be analyzed. Analyses have also been made of samples of the manufacturing wastes discharged into the stream and its tributaries.

The results of the investigation show that the river, within the limits of Brockton, West Bridgewater and East Bridgewater, is very badly polluted and is a nuisance. One of the causes of this nuisance is the manufacturing refuse discharged from your works into the Vinegar Swamp drain, so called, which has an outlet into the Salisbury Plain River within the limits of the city of Brockton.

The act authorizing the city of Brockton to provide for surface drainage (chapter 309 of the Acts of the year 1888) contains the following provision: —

> In case of the violation of any of the provisions of this act, or the creation of a nuisance, appeal may be had to the state board of health, who may order the abatement of any nuisance, if in their judgment there is cause therefor.

Under the circumstances, the Board recommends that you purify the wastes discharged from your works to such an extent that the effluent will not create objectionable conditions when discharged into any brook or natural stream within the limits of the city of Brockton.

Brockton (Empire Laundry Company).

To the Empire Laundry Company, Brockton, Mass. Dec. 2, 1909.

Gentlemen: — Complaint has been made to this Board of a nuisance in the Matfield, or Salisbury Plain, River in the town of East Bridgewater, caused by the discharge into the stream of polluting substances beyond the limits of that town, and in response to this application the Board has caused an examination of the river to be made and samples of water collected at numerous points along the course of the river and its tributaries to be analyzed. Analyses have also been made of samples of the manufacturing wastes discharged into the stream and its tributaries.

The results of the investigation show that the river, within the limits of Brockton, West Bridgewater and East Bridgewater, is very badly polluted and is a nuisance. One of the causes of this nuisance is the wash water discharged from your establishment into Salisbury Brook, which is a tributary of the Salisbury Plain River within the limits of the city of Brockton.

The act authorizing the city of Brockton to provide for surface drainage (chapter 309 of the Acts of the year 1888) contains the following provision: —

> In case of the violation of any of the provisions of this act, or the creation of a nuisance, appeal may be had to the state board of health, who may order the abatement of any nuisance, if in their judgment there is cause therefor.

Under the circumstances, the Board recommends that you purify the wastes discharged from your works to such an extent that the effluent will not create objectionable conditions when discharged into any brook or natural stream within the limits of the city of Brockton.

Brockton (Hide-ite Leather Company).

To the Hide-ite Leather Company, Brockton, Mass. Dec. 2, 1909.

Gentlemen: — Complaint has been made to this Board of a nuisance in the Matfield, or Salisbury Plain, River in the town of East Bridgewater, caused by the discharge into the stream of polluting substances beyond the limits of that town, and in response to this application the Board has caused an examination of the river to be made and samples of water collected at numerous points along the course of the river and its tributaries to be analyzed. Analyses have also been made of samples of the manufacturing wastes discharged into the stream and its tributaries.

The results of the investigation show that the river, within the limits of Brockton, West Bridgewater and East Bridgewater, is very badly polluted and is a nuisance. One of the causes of this nuisance is the manufacturing refuse discharged from your works into Trout Brook, so called, which is a tributary of the Salisbury Plain River within the limits of the city of Brockton.

The act authorizing the city of Brockton to provide for surface drainage (chapter 309 of the Acts of the year 1888) contains the following provision: —

In case of the violation of any of the provisions of this act, or the creation of a nuisance, appeal may be had to the state board of health, who may order the abatement of any nuisance, if in their judgment there is cause therefor.

Under the circumstances, the Board recommends that you purify the wastes discharged from your works to such an extent that the effluent will not create objectionable conditions when discharged into any brook or natural stream within the limits of the city of Brockton.

Concord.

Dec. 6, 1909.

To Mr. John M. Keyes, *Chairman, Board of Health, Concord, Mass.*

Dear Sir: — In response to complaints from your board and others of the pollution of the Assabet River, the State Board of Health has recently caused the sources of pollution of the stream to be examined and samples of the waters of the river and of the various polluting wastes discharged into it to be analyzed. The results show that the chief cause of the pollution of the stream in Concord is the waste discharged from the mills of the American Woolen Company in Maynard, together with a small amount of sewage from the town.

The State Board of Health has recommended to the American Woolen Company and to the town the removal of the polluting matter from the stream. Copies of the communications of the Board to the American Woolen Company and to the town of Maynard are enclosed herewith.

East Bridgewater.

Dec 6, 1909.

To the Board of Health of the Town of East Bridgewater, Mass.

Gentlemen: — In response to your complaint of a nuisance in the Matfield River in East Bridgewater due to the discharge of polluting matters into that stream at points outside the town, the State Board of Health has caused the river to be examined and samples of its waters

and of waste waters discharged into the stream at various points to be analyzed. The results show that the stream is badly polluted within the limits of the city of Brockton, and the Board has notified the owners of establishments which are the chief sources of pollution as to the objections to the discharge of these wastes into the streams. Copies of these communications are enclosed herewith.

Framingham (Louis Hill).

Nov. 11, 1909.

To Mr. Louis Hill, *49 Waverly Street, South Framingham, Mass.*

Dear Sir: — The State Board of Health has considered your application of October 7 for the approval of the location of a proposed slaughter-house to be constructed on the south side of Morton Street east of Coolidge Street in South Framingham, and has caused the locality to be examined by one of its engineers.

It appears that there is a sewer in the neighborhood which is available for the disposal of such foul drainage as may reasonably be admitted to a system of sewers, and if the slaughter-house is located at the place now proposed it is unlikely, if properly constructed and maintained, to create a nuisance in the neighborhood.

The Board approves the location of the proposed slaughter-house at a point on the easterly knoll on your land about 750 feet east of Coolidge Street.

It is stated in the application that the building is to be 16 feet by 20 feet, and is to be constructed with a concrete floor and concrete walls to a height of 5 feet above the floor, above which the walls and roof are to be of wood; but no plan of the structure or details of the method of disposing of the drainage have been presented. The building should be provided with suitable means of draining into the sewers of the town of Framingham such liquid wastes as may reasonably be admitted to them and preventing the entrance of matters which might interfere with the operation of the sewers or the sewage disposal works. It is necessary that this slaughter-house shall be maintained at all times in such manner as not to cause a nuisance or the pollution of any of the neighboring waters, tributaries of the metropolitan water supply system, contrary to the provisions of rule 13 of the rules and regulations for the sanitary protection of the waters used by the metropolitan water board made under authority of chapter 488 of the Acts of the year 1895, a copy of which is appended hereto.

LAWRENCE.

SEPT. 8, 1909.

To the Board of Health of the City of Lawrence, MR. ROSCOE DOBLE, *Clerk.*

GENTLEMEN: — The State Board of Health received from you on July 31, 1909, an application stating that a nuisance in the Spicket River was causing much trouble to people residing in that valley, and requesting the advice and assistance of the Board as to preventing the nuisance; and in response to this application the Board has caused the river and the factories, sewers and other possible sources of pollution in its neighborhood to be examined and samples of the waters of the stream to be analyzed.

Inspections of the river during the past month have shown that its waters are reasonably clean and unobjectionable down to the Arlington mills, though they receive considerable pollution above that point; but below these mills the stream has been offensive throughout the remainder of its course. Its condition has, however, greatly improved during the past few days.

The quantity of water flowing in the river during the past month has been extremely small. Practically the entire flow of the stream in the dry season is used in the various processes in the Arlington mills and the greater portion of this water is discharged into the sewers of Lawrence and Methuen and not returned to the river until within a short distance above its mouth. The remaining portion of the wastes from the Arlington mills is discharged into the river. Owing to the location of the various drains and their outlets, it has not been practicable to examine carefully all of the wastes or to determine accurately their quantity, though facilities have been furnished by the management of the mills for making an examination of such outlets as were accessible and information has been furnished as to the approximate location of the others and the character of the wastes discharged therefrom.

From such information as has been obtained by the Board and has been furnished by the management of the Arlington mills, it appears that the total quantity of water used in the various processes in these mills amounts to more than 9,000,000 gallons per day, of which about 5,770,000 gallons per day is discharged into the sewers and finds an outlet into the river through the main sewer of the Spicket River valley at Garden Street near its mouth. The remainder, amounting to 3,500,000 gallons per day is discharged into the river.

Of the total quantity of waste water discharged into the sewers about 2,170,000 gallons per day are used for condensing in the cotton mill and top mill and elsewhere, and this water is probably not polluted

noticeably by such use and would doubtless be unobjectionable if discharged into the river. There are also about 380,000 gallons of water used daily in humidifiers, which is not polluted in the process and should be discharged into the river. There is, furthermore, a quantity of water, amounting to about 1,200,000 gallons per day, used in the process of caustic recovery, so called, which appears upon analysis to be but slightly polluted, and there is little doubt that this water also could be discharged into the river without objection.

Of the total quantity of wastes discharged into the river, amounting to a little less than 3,500,000 gallons per day, a part, amounting to about 1,600,000 gallons per day, consists of waste waters from the process of dyeing cloth and somewhat more than 1,800,000 gallons per day consists of condenser water from engines in the spinning mills. The remainder is used for general purposes, including the running of certain elevators. Filter plants are in use in the dye-house, the wash water from which is returned to the mill-pond above the dam.

All other wastes from these mills are discharged into the sewers, and as practically the entire flow of the river above the mills is at present used in the various processes, the quantity of water flowing in the river below the mills consists chiefly of the wastes described above. The condenser water is doubtless unobjectionable, but analyses of the discharge from the dye-house show that these wastes contain a large quantity of putrescible organic matter.

The sewage of the thickly settled portions of the valley of the Spicket River is collected into a large main sewer, which passes down the valley from the neighborhood of the Arlington mills and discharges into the river at Garden Street a short distance above its mouth. The sewers in the town of Methuen are constructed on the separate plan, but those of the city of Lawrence are combined sewers and collect storm water as well as sewage in the districts which they serve. The system is not large enough to remove, in addition to the sewage, all of the rain water entering the sewers in Lawrence at times of heavy rain, and provision has been made for the discharge of a portion of the mingled sewage and storm water at such times into the Spicket River.

Examinations made during and after the rain of August 17 and again during the rain of September 1 show that in ordinary heavy rain storms in summer, when the precipitation is distributed over several hours, it is not probable that a very large quantity of sewage and storm water overflows into the Spicket River, and in summer showers of considerable intensity the amount of sewage which would overflow into the river if the connections with the main sewer were kept in proper order, would probably not be very large; but the connections between the laterals

and the main Spicket River valley sewer evidently at times become clogged, and a part or even the whole flow of some of these tributary sewers sometimes discharges into the river continuously even in times of dry weather. On the day after the rain of September 1, one of the overflows was found to be discharging continuously practically the entire flow of one of the sewers into the Spicket River, while another connection was partially clogged. Such pollution is entirely unnecessary and would not occur if proper provision for the care of these sewers were made and enforced by the city. The observations further indicate that the full capacity of the main sewer, even when all the connections are kept in order, is not now utilized for the removal of storm water in storms of ordinary intensity and that the overflow of storm water can probably be reduced considerably by such changes in the connections and overflows as will provide for utilizing the full capacity of the main sewer at such times.

As a result of its investigations the Board concludes that the chief cause of the offensive condition of the river is the dye wastes discharged from the Arlington mills, which during the dry season constitute a large portion of the flow in the stream. The great improvement that took place in the condition of the stream and the character of its waters, as shown by chemical analyses, after the recent shutting-down of these mills, leaves no doubt as to the chief cause of the trouble. The river is, nevertheless, very badly polluted in other ways, the most important of which is the sewage discharged through overflows from tributaries of the Spicket River valley sewer, which at times, through lack of care, discharge considerable quantities of sewage into the stream even in dry weather.

There are also apparently a number of connections through which sewage is discharged directly into the river from dwelling houses and buildings along its banks, and in some places it appears to be a place of disposal for small quantities of garbage and other refuse.

The banks of the river below the Arlington mills are not kept in repair and are overgrown in many places with vegetation which holds the offensive material conveyed by the water as well as garbage and other matters thrown into the stream. The bottom of the river below the Arlington mills is covered extensively with deposits of organic matter evidently derived largely from the deposition of suspended matters in the wastes discharged from the Arlington mills, but probably also from the sewage and storm water discharged into the stream at times of rain. Under the existing conditions the bed and banks of the river are exposed to some extent at times of low flow, especially at night and on Sundays,

and the nuisance from the river appears to be somewhat greater than usual at such times.

The Board recommends that all the dye wastes now discharged into the river from the Arlington mills, which amount apparently to about 1,600,000 gallons per day, be removed from the river and discharged into the sewers; and that the water which is now used in these mills for condensing, in the cotton mill, top mill and elsewhere, the water used in the humidifiers and the water used in the caustic recovery process, be removed from the sewers and returned to the river.

If all of the waters indicated, amounting to about 3,750,000 gallons per day, should be returned to the river instead of being discharged into the sewers, as at present, and if the dye wastes, amounting to about 1,600,000 gallons per day, which are now the chief cause of the pollution of the river, should be removed to the sewers, the serious pollution of the river would be checked, its flow in the summer season greatly increased, — thereby keeping the bottom and banks more completely covered, — and the main sewer would be relieved of a large portion of its flow, thus increasing its capacity for the removal of storm water at times of rain and diminishing the overflow of sewage into the river at such times.

There appears to the Board no good reason why the changes indicated above should not be made. It is possible that, with the reduced flow in the sewers, the large quantity of heavy matter now discharged into them from the process of washing wool in the Arlington mills would tend to form deposits, but danger of trouble from that cause can be prevented by passing this waste through settling tanks before discharging it into the sewer. The settling tanks need only be large enough to cause the deposit of heavy matters, such as sand, which will not readily be carried along by the current in the sewer. The tanks used for this purpose should, of course, be cleaned at the necessary intervals, and the material deposited can be dumped at some convenient place without objection.

The Board further recommends that it be made the duty of some one connected with the department having charge of the maintenance of the sewers to examine the connections between the tributary sewers and the main sewer and see that these connections, as well as the overflow outlets, are kept open and free from obstruction. For this purpose the connections and overflows should be examined immediately after every storm and at least as often as once a week. It will be important, also, to remove from the river all direct connections through which sewage is now discharged into the stream from dwelling houses and buildings along its banks, and prevent its use as a place of deposit for garbage and other refuse. The banks of the river should be put in repair and be kept clean

as far down as the lowest water of summer will permit. If these and the other changes suggested should be carried out during the present year, it is probable that the offensive organic matter collected on the bed of the river will be removed by the high flows of the water in the winter and spring or rendered sufficiently inoffensive by natural processes before another summer, and that a recurrence of the nuisance will be prevented.

It is advisable that, after the changes suggested in the disposal of the wastes of the Arlington mills have been made, a careful observation be made by the city, under the direction of the city engineer, of the height of flow in the Spicket River valley sewer at times of heavy rain, and the connections of tributary sewers so arranged as to deliver as much of the flow of the tributary sewers into the main sewer as the latter is capable of carrying at all times. If, as a result of these investigations, it is found necessary or desirable to introduce automatic regulators on any of these connections, they should be provided.

While the small quantity of mill wastes discharged into the stream from factories located above the Arlington mills has not yet had a very appreciable effect upon the character of the water of the river, it is important that the objectionable wastes from these factories be discharged into the sewers.

The discharge of sewage at Garden Street creates a considerable odor in the neighborhood. The location of the main outlet of sewage from the Spicket River valley at this point appears to have been simply a temporary arrangement and it is desirable that the sewage be removed as soon as practicable to some suitable place of disposal.

Maynard.

To the Selectmen of the Town of Maynard, Mass. Dec. 6, 1909.

Gentlemen: — Complaint has been made to the State Board of Health of a nuisance in the Assabet River at Maynard, and examinations show that the cause of the nuisance is chiefly the discharge of polluting matters from the mills of the American Woolen Company, but it is also due in part to the discharge of sewage into the stream from the mills and also from sewers in the streets of the town. In order to protect the public health it is essential that the pollution of the stream be prevented, and the Board recommends that action be taken by the town of Maynard for the removal or purification of all the sewage now discharged into the stream through sewers or drains in the town.

A copy of a communication to the American Woolen Company relative to the prevention of the pollution of the stream by the wastes from the mills of that company is enclosed herewith.

MAYNARD (AMERICAN WOOLEN COMPANY).

DEC. 2, 1909.

To the American Woolen Company, Maynard, Mass.

GENTLEMEN: — Complaint has been made to this Board of a nuisance in the Assabet River at points below the town of Maynard, and careful examinations made by the Board from time to time during the past year show that, while the river is polluted at some points in the upper portions of its course, its condition above Maynard is not objectionable either in appearance or odor; but it becomes offensive immediately below the town and continues to be a serious nuisance throughout much of the remainder of its course to its confluence with the Sudbury at Concord.

The chief cause of the offensive condition of the river below Maynard is the discharge into the stream of manufacturing waste, from the processes of wool-scouring, dyeing, cloth-washing and other processes carried on in your mills, and of sewage which is discharged both from the mills and from a limited number of sewers in the town.

It is essential, for the prevention of further nuisance in the valley below this mill and the protection of the public health, that the pollution of the stream by sewage and manufacturing wastes from your mills in Maynard shall be discontinued.

From such investigations as the Board has been able to make as to the quantity and character of the manufacturing wastes discharged from the mill, it appears that the most objectionable portions of the wastes are those resulting from the scouring of wool, the amount of which apparently averages about 100,000 gallons per day, though at times the quantity is much larger. These wastes contain an excessive quantity of fats and are, in consequence, very difficult to purify, and they will doubtless require a preliminary treatment for the removal of fats before they can be purified. A great quantity of waste results from the processes of dyeing, washing and rinsing cloth, the total quantity of these wastes probably averaging more than 3,000,000 gallons per day, and amounting to nearly 5,000,000 gallons per day at the maximum. A portion of these wastes, however, consisting of the water used in rinsing the cloth, may be clean enough so that it can be discharged directly into the river without objection. A further very objectionable waste is that resulting from the washing of rags in the shoddy mill, the quantity of this waste amounting apparently to about 40,000 gallons per day on an average, though evidently at times reaching a much higher figure.

Experiments made by direction of the Board upon the purification of these wastes and wastes of similar character show that they can be purified by sedimentation and subsequent straining and filtration to

such an extent as to prevent further serious pollution of the river and at a cost which is not excessive.

The Board recommends that you provide without delay works for removing from the river the sewage and manufacturing wastes from your factory and for their treatment or purification in such a way that they will not cause further injury to the stream. It is important that, in the treatment of these wastes, you secure the assistance of an engineer of experience in matters relating to the treatment and disposal of sewage and manufacturing wastes, and the engineer of the Board will supply your expert with such information as has been collected by the Board relative to the quantity and character of these wastes and the methods by which they can be purified.

New Bedford.

June 3, 1909.

To the Board of Health of the City of New Bedford.

Gentlemen: — In response to your verbal request for advice as to the condition of the sea water in Clark's Cove near the westerly side of Clark's Point and a little over half a mile from the southerly end thereof, where you propose to locate a public bath-house, the Board has caused samples of the sea water from this locality and from other places in this region to be analyzed.

The results of the analyses show that, while the water at the upper end of Clark's Cove is grossly polluted by sewage, the water along the shore at the proposed bath-house is not materially affected thereby at the present time.

North Adams.

Dec. 2, 1909.

To Hon. John H. Waterhouse, *Mayor of the City of North Adams.*

Dear Sir: — The State Board of Health has at previous times called attention to the polluted condition of the Hoosick River, caused by the discharge into the stream of sewage and manufacturing wastes, chiefly in the city of North Adams. The effect of the pollution of this river in North Adams has been increasing from year to year until at the present time the stream is foul and offensive, and its condition is very objectionable in the lower part of the city and throughout the remainder of its course in the State. A considerable quantity of sewage is still discharged into the river above the main sewer outlet, and, in connection with large quantities of wastes discharged from manufacturing establishments and pollution from points above, creates objectionable conditions in the main stream and each of its principal tributaries in the central portion of the city.

Complaints are made of the foul condition of the stream, and, in the opinion of the Board, the time has come when, in order to protect the public health in the valley of the Hoosick River, the sewage by which it is now polluted must be removed and purified.

The Board is informed that the preparation of plans for treating the sewage of the city of North Adams was begun early in the present year, and the Board recommends that the necessary steps be taken to enable the city to begin the construction of works for purifying its sewage during the year 1910. The works should, so far as practicable, make provision for receiving and purifying, in addition to the sewage, the more objectionable of the manufacturing wastes which contribute very seriously to the pollution of the river, but it will be necessary to avoid taking into the sewers any manufacturing waste or substance which may interfere with the operation of the sewers or disposal works, until such waste is so treated as to prevent danger of such interference.

Salem and Peabody. June 10, 1909.

To the Boards of Health of the City of Salem and the Town of Peabody.

Gentlemen: — In response to a request from the Board of Health of the city of Salem for an examination of the character of the wastes discharged into the North River or its tributaries from factories in Salem and Peabody, the Board has caused an examination of the method of waste disposal at the factories in the valley of the North River and its tributaries to be made and samples of such wastes as were being discharged into the streams to be analyzed.

The chief sources of pollution of the river and its tributaries at the time of this examination were found to be the following: —

1. The factory of the Essex Glue and Gelatine Company, in Peabody, located a short distance north of Goldthwaite's Brook. The total quantity of liquid wastes discharged from this factory amounted, when these examinations were made, to over 300,000 gallons per day, and an analysis shows that the waste contained a very large quantity of organic matter and that a little over 30 per cent. of the solid matter was in suspension. This waste could be discharged into the Peabody sewers by laying approximately 400 feet of pipe. The sludge removed from the settling basins now in use is deposited at the edge of a ditch leading to the brook, and there are indications that some of it finds its way into the stream at times of heavy rain. Provision can be made without difficulty to prevent the pollution of the brook by the sludge.

2. The factory of the American Glue Company, near Goldthwaite's Brook. The liquid wastes from this factory are discharged into the

sewers but at the time the examination was made sludge from the settling tanks, through which the liquid wastes are passed before flowing into the sewers, was being pumped upon sludge beds near Goldthwaite's Brook, and the sludge, after flowing over the beds, was finding its way into the brook through an opening in the embankment of one of the beds. This sludge contains a very large quantity of organic matter and over 90 per cent. of the solid matter is in suspension. Adequate provision should be made for the proper treatment and disposal of this sludge, and the sludge beds should be so constructed as to prevent further danger of the escape of any of the sludge into the brook.

3. The Danvers Bleachery, near Goldthwaite's Brook. A very large quantity of water, amounting probably to more than 2,000,000 gallons per day, is used in this establishment, and much of it can evidently be discharged untreated directly into the stream without danger of causing a nuisance. A small part of the wastes, consisting chiefly of spent dyes and amounting to about 5,000 gallons per day, is passed through a settling tank. It is not unlikely that it will be necessary to divert a portion of the wastes of this factory from the brook or to subject them to some form of treatment, but a more extended investigation will be necessary before it will be practicable to determine definitely what further treatment, if any, the wastes of this factory require beyond that which they now receive.

4. The tannery of the United States Tanned Pigskin Company is located on Strongwater Brook, and the wastes, amounting probably to between 4,000 and 5,000 gallons per day, are discharged, after passing through crude settling tanks and a straw strainer, directly into the brook. An analysis of the wastes after treatment shows that they still contain a very large quantity of organic matter, about one-third of which is in suspension. Under present conditions they pollute the brook seriously. The wastes could apparently be discharged into the sewers by laying a pipe not over 300 feet in length.

5. The A. C. Lawrence Leather Company, located on Proctor's Brook, discharges the water used in treating hides, amounting probably to between 5,000 and 10,000 gallons per day, directly into the brook. This water at times does not contain a very considerable quantity of organic matter, but at other times contains considerable suspended matter. If the suspended matter should be removed there would probably be no objection to continuing the discharge of this water into the brook, unless it should become more objectionable in character than was found to be the case at the time of the recent examinations.

6. The A. L. Kraus Company, on Proctor's Brook, discharges the bulk

of its waste into the sewer, after passing through settling basins. Small amounts of floor drainage, however, enter the river from one of the buildings. These wastes are objectionable in character and should be discharged with the others into the sewer.

7. The J. A. Lord, Jr., tannery, located near Proctor's Brook, is connected with the sewer, and the wastes from this tannery are ordinarily discharged into the sewer. The drains are, however, so arranged that the wastes can be turned directly into the brook and occasionally the stream has been found to be seriously polluted in the neighborhood of the tannery. It is desirable to re-arrange the drains so that the wastes will enter the sewers at all times.

8. The tannery of the Armstrong Leather Company is located near the North River in Peabody, not far from the Salem boundary. Most of the wastes from the factory enter the sewers after passing through a settling basin, but a small portion of the wastes, amounting to probably less than 5,000 gallons per day, is being discharged directly into the North River. The wastes are objectionable in character and contribute to the pollution of the stream near the factory. Their further discharge into the stream should be prevented.

9. The tannery of the Thayer, Foss Company is located on the southerly side of the North River opposite the Armstrong tannery. The wastes from this tannery are collected in a well and pumped thence to the sewers. The capacity of the well is small for the quantity of waste handled and at times, when the pump is out of order, the wastes are allowed to discharge into the North River through an overflow pipe. The well should be enlarged so as to store a sufficient quantity of waste to allow for repairs upon the pump or duplicate pumps could be provided, so that interruption of the pumping would not be necessary whenever repairs were required. The overflow of these wastes causes serious pollution of the stream at times.

10. The factory of J. F. Ingraham, Jr., & Company is located just below that of the Thayer, Foss Company. Nearly all of the wastes from this factory are discharged through settling basins into the sewers, but the floor of one of the rooms in the dye-house drains into the North River. The floor in question should be made tight and so arranged that the drainage from it would enter the sewers with the other wastes.

11. The tannery of Peter Sim & Son is located on the south side of the North River within the limits of Salem. All of the liquid wastes from this tannery are discharged through a settling basin into the sewers, but the sludge which is removed from the basin at regular intervals is deposited on the banks of the river, and at times of high water or heavy

rains small quantities are washed into the stream. Provision should be made for preventing the pollution of the stream by sludge from this factory.

12. The Carr Leather Company occupies a tannery of the F. E. Cottle Leather Company on the northerly side of the North River, near Flint Street in Salem. All of the wastes from this factory, amounting probably to between 50,000 and 100,000 gallons per day, are discharged into the stream after passing through a small settling basin. The wastes are objectionable in character and their effect in polluting the stream is very noticeable. There is no sewer on Mason Street near the factory, but it would apparently be possible to connect the factory with the sewer in Flint Street by a sewer approximately 500 feet in length.

The foregoing comprise the specific cases of pollution found to exist at the time the investigations were made. At many of the tanneries which have been visited it was found that the outlets through which the wastes were formerly discharged into the river previous to the construction of the sewers were still in existence, and it is very probable in some cases that they are still used occasionally. The pollution of the stream from such sources is likely to continue unless prevented by a rigid inspection. The best plan would be to close permanently or remove these former outlets and all outlets through which wastes can be discharged directly into the streams.

In addition to the wastes discharged from the factories, the North River below North Street in Salem receives a small amount of pollution from dwelling houses, chiefly located along the old sewers between the new intercepting sewer and the former sewer outlets. There are also some indications that sewage is still discharged into the streams in Peabody from dwelling houses not yet connected with the sewers. It is probable that when the principal remaining sources of pollution have been prevented, it will be less difficult to locate the minor ones and secure their removal from the streams.

Williamstown.

Dec. 2, 1909.

To the Board of Selectmen of the Town of Williamstown.

Gentlemen: — Complaint has been made to this Board of the objectionable condition of the Hoosick River, and examinations made by the Board show that the river is very badly polluted by sewage and manufacturing waste. A portion of the sewage which now pollutes the river is discharged from the sewers of the town of Williamstown.

In order to prevent further nuisance in the valley of this stream and

protect the public health, it will be necessary that the use of the stream as a place of disposal for the sewage of the cities and towns on its banks shall be discontinued. The sewers of the town of Williamstown are discharged into the stream at various points along its course, and the Board recommends that a plan be prepared without delay for collecting the sewage of the town from all of the existing sewer outlets and for purifying it at some suitable place or places to such an extent as to prevent the further serious pollution of the river.

Examination of Public Water Supplies.

Examination of Public Water Supplies.

The examination of public water supplies in Massachusetts was begun in the year 1887, under the provisions of chapter 274 of the Acts of the year 1886, entitled "An Act to protect the Purity of Inland Waters," and has been carried on up to the present time under the provisions of that and subsequent laws.

The results of the earlier of these examinations were published in the special report of the Board on the examination of water supplies in 1890, and results of the examinations made in subsequent years have been published in the annual reports. The present report contains such information as is deemed to be of especial interest concerning the various public water supplies in the State, including a description of the new works and changes in existing works since 1906, when a similar statement was published. This report also contains the results of the chemical analyses of the various sources, presented in tables and summaries so arranged as to afford a means of comparing the various waters with respect to organic matter, hardness and the other properties considered in determining the quality of a water used for drinking.

At the end of the year 1909 all of the 33 cities in Massachusetts and 159 of the 321 towns were provided with public water supplies. This list includes all but 1 of the places in the State having, according to the census of 1905, a population in excess of 5,000, and there are only 9 towns in the State having a population in excess of 2,500 which are not provided with public water supplies. The total population, according to the census of 1905, of the cities and towns provided with public water supplies is 2,812,238, or 94 per cent. of the total population of the State. In nearly all of the cities and towns having a public water supply there are considerable areas in which the public supply is not available, but these areas are sparsely populated. Outside of the areas provided with public water supplies and the places supplied with water from mills and other private sources, the sources of water supply of the inhabitants of the State are chiefly wells located in the immediate vicinity of the owner's dwelling.

CITIES AND TOWNS SUPPLIED WITH WATER FROM PUBLIC WORKS.

The following table gives a list of the cities and towns having public water supplies which are available to the whole or to a portion of their territories, together with the population of each, the date of introduction of the works, the ownership of the works and the source or sources of water supply at the present time: —

Table No. 1.

City or Town.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Metropolitan Water District:[1] —				
Arlington,	9,668	1872	Town,	Wachusett Reservoir on South Branch of Nashua River, Clinton; Framingham Reservoir No. 2 on Sudbury River, Framingham; Reservoirs on tributaries of Sudbury River, as follows: Sudbury Reservoir on Stony Brook, Southborough, which receives water from Wachusett Reservoir; Framingham Reservoir No. 3 on Stony Brook, Framingham, which receives water from Sudbury Reservoir; Hopkinton Reservoir on Indian Brook, Hopkinton; Ashland Reservoir on Cold Spring Brook, Ashland; Lake Cochituate, Wayland and Natick.
Belmont,	4,360	1887	Town,	
Boston,	595,380	1848	City,	
Chelsea,	37,289	1867	City,	
Everett,	29,111	1867	City,	
Lexington,	4,530	1884	Town,	
Malden,	38,037	1870	City,	
Medford,	19,686	1870	City,	
Melrose,	14,295	1870	City,	
Milton,	7,054	1885	Town,	
Nahant,	922	1885	Town,	
Quincy,	28,076	1884	City,	
Revere,	12,659	1884	Town,	
Somerville,	69,272	1867	City,	
Stoneham,	6,332	1883	Town,	
Swampscott,	5,141	1885	Town,	
Watertown,	11,258	1885	Town,	
Winthrop,	7,034	1884	Town,	
Abington,	5,081	1887	Town,	Big Sandy Pond, Pembroke.
Rockland,	6,287	1887	Town,	
Adams,	12,486	1874	Fire district,	Bassett Brook, Dry Brook, Cheshire; tubular wells near Hoosick River, Cheshire.
Agawam,	2,795	1877	Private,	Springs.
Amesbury,	8,840	1885	Town,	Two systems tubular wells.
Amherst,	5,313	1880	Private,	Amethyst Brook, Pelham, on which there is a storage reservoir; spring in Pelham.
Andover,	6,632	1890	Town,	Haggett's Pond.

[1] This district was established by an act of the Legislature of 1895. The dates of introduction of water into the cities and towns of the district are the dates of completion of the earlier works.

Table No. 1 — Continued.

City or Town.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Arlington,	–	–	– –	See Metropolitan Water District.
Ashburnham,	1,851	1870	Town,	Storage reservoir.
Ashfield,	959	1904	Private,	Bear Swamp Brook.
Athol,	7,197	1875	Town,	Storage reservoir in Phillipston; storage reservoir on Buckman Brook.
Attleborough,	12,702	1873	Town,	Large wells near Seven Mile River.
Avon,	1,901	1890	Town,	Large well and tubular wells.
Ayer,	2,386	1887	Town,	Large well and tubular wells.
Barre,	2,558	1895	Private,	Storage reservoir.
Bedford,	1.208	1909	Town,	Large well and filter.
Belmont,	–	–	– –	See Metropolitan Water District.
Beverly,	–	–	– –	See Salem.
Billerica,	2,843	1898	Town,	Tubular wells near Concord River.
Blandford,	746	1909	Fire district,	Freeland Brook.
Boston,	–	–	– –	See Metropolitan Water District.
Braintree,	6,879	1887	Town,	Filter gallery and tubular wells near Little Pond; Great Pond (used also by Randolph and Holbrook).
Bridgewater,	6,754	1888	Private.	Tubular wells and large wells near Town River.
East Bridgewater,	3,169	1888	Private,	
Brockton,	47,794	1880	City,	Silver Lake, Pembroke; storage reservoir on Salisbury Brook.
Whitman,	6,521	1883	Town,	
Brookfield,	2,388	1889	Town,	Storage reservoir; Quaboag River; tubular wells near Lake Lashaway.
Brookline,	23,436	1875	Town,	Tubular wells and filter gallery near Charles River.
Cambridge,	97,434	1856	City,	Storage reservoir on Stony Brook, Waltham and Weston; storage reservoirs on Hobbs Brook, Waltham, Lincoln and Lexington; Fresh Pond.
Canton,	4,702	1889	Town,	Large well and tubular wells at Springdale; large well at Henry's Spring, Stoughton.
Chelmsford,	4,254	1907	Fire district,	Tubular wells near Crystal Lake.
Chelsea,	–	–	– –	See Metropolitan Water District.
Cheshire,	1,281	1876	Private,	Thunder Brook; Kitchen Brook.
Chester,	1,366	1893	Fire district,	Austin Brook.
Chicopee,	20,191	1845	City,	Dingle Brook Reservoir; Morton Brook; Cooley Brook.
Clinton,	13,105	1882	Town,	Lyndes Brook, Spring Basin and Heywood Brook, Sterling.
Lancaster,	2,406	1885	Town,	
Cohasset,	2,727	1886	Private,	Two systems tubular wells; filter gallery near Lily Pond; large well near Bound Brook.

Table No. 1 — Continued.

City or Town.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Colrain,	1,780	1902	Fire district,	Mountain Brook.
Concord,	5,421	1873	Town,	Sandy Pond, Lincoln; Nagog Pond, Acton.
Dalton,	3,122	1884	Fire district,	Reservoirs on Egypt Brook.
Danvers,	9,063	1876	Town,	Middleton Pond, Middleton.
Middleton,	1,068	1876	Town,	Middleton Pond, Middleton.
Dedham,	7,774	1881	Private,	Large well and tubular wells near Charles River.
Deerfield,	2,112	1903	Water supply district,	Roaring Brook, Whately.
Dracut,	3,537	1900	Private,	Tubular wells.
		1906	Water supply district,	Tubular wells.
East Bridgewater,	–	–	– –	See Bridgewater.
Easthampton,	6,808	1870	Town,	Tubular wells near Broad Brook; Bassett Brook.
Easton,	4,909	1887	Village district,	Large well.
Edgartown,	1,175	1906	Private,	Tubular wells
Erving,	–	–	– –	See Montague.
Everett,	–	–	– –	See Metropolitan Water District.
Fairhaven,	4,235	1894	Private,	Tubular wells near Nasketucket River; tubular wells near Mattapoisett River.
Fall River,	105,762	1874	City,	North Watuppa Lake.
Falmouth,	3,241	1899	Town,	Long Pond.
Fitchburg,	33,021	1872	City,	Scott Reservoir; Falulah Reservoir; Meetinghouse Pond, Westminster; Wachusett Lake, Westminster and Princeton.
Foxborough,	3,364	1891	Water supply district,	Tubular wells.
Framingham,	11,548	1885	Town,	Filter gallery near Farm Pond; Sudbury Aqueduct.
Franklin,	5,244	1884	Town,	Tubular wells near Beaver Pond; Beaver Pond.
Gardner,	12,012	1882	Town,	Crystal Lake.
Gill,	1,023	1888	Private,	Spring.
Gloucester,	26,011	1885	City,	Dikes Brook Reservoir; Haskell Brook Reservoir; Wallace Reservoir.
Grafton,	5,052	1886	Private,	Large well near Quinsigamond River.
Great Barrington,	6,152	1867	Fire district,	East Mountain Reservoir; Green River.
Greenfield,	9,156	1870	Fire district,	Storage reservoirs on Glen Brook, Leyden; Green River.
Groton,	2,253	1897	Private,	Large well near Baddacook Pond.
Hadley,	1,895	1905	Water supply district,	Storage reservoirs on Harts Brook.
Hardwick,	3,261	1887	Private,	Tubular wells.
Hatfield,	1,779	1896	Town,	Storage reservoir on Running Gutter Brook.

Table No. 1 — Continued.

City or Town.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Haverhill,	37,830	1802	City,	Crystal Lake; Pentucket Lake; Saltonstall Lake; Kenoza Lake; Johnson's Pond; Millvale Reservoir.
Hingham,	4,819	1880	Private,	Accord Pond; large well near Fulling Mill Pond.
Hull,	2,060	1882	Private,	
Hinsdale,	1,452	1889	Fire district,	Storage reservoir.
Holbrook,	–	–	– –	See Randolph.
Holden,	2,640	1905	Town,	Muschopauge Lake (used also by Rutland).
Holliston,	2,663	1891	Private,	Large well.
Holyoke,	49,934	1873	City,	Manhan River, Southampton; Wright and Ashley Pond; high-service reservoir; Whiting Street Reservoir, Northampton.
Hopedale,	–	–	– –	See Milford.
Hopkinton,	2,585	1884	Town,	Tubular wells.
Hudson,	6,217	1884	Town,	Gates Pond, Fosgate Brook, Berlin.
Hull,	–	–	– –	See Hingham.
Huntington,	1,451	1899	Fire district,	Cold Brook, Blandford; tubular wells near Westfield River.
Hyde Park,	14,510	1885	Private,[1]	Tubular wells near Neponset River; tubular wells near Mother Brook.
Ipswich,	5,205	1894	Town,	Storage reservoir on Dow's Brook.
Kingston,	2,205	1886	Town,	Tubular wells.
Lancaster,	–	–	– –	See Clinton.
Lawrence,	70,050	1875	City,	Merrimack River, filtered.
Lee,	3,972	1881	Private,	Storage reservoir on Codding Brook; Basin Pond Brook.
Leicester,	3,414	1891	Water supply district,	Large wells.
Lenox,	3,058	1875	Private,	Storage reservoirs; Yokun River.
Leominster,	14,297	1873	Town,	Haynes, Morse and Fall Brook reservoirs.
Lexington,	–	–	– –	See Metropolitan Water District.
Lincoln,	1,122	1874	Town,	Sandy Pond.
Longmeadow,	964	1895	Town,	Cooley Brook.
Lowell,	94,889	1872	City,	Tubular wells near Merrimack River; tubular wells near Beaver Brook.
Ludlow,	–	–	– –	See Springfield.
Lynn,	77,042	1871	City,	Breed's Reservoir; Birch Reservoir, Walden Reservoir, Hawkes Reservoir, Lynn and Saugus; Saugus River, Saugus.
Saugus,	6,253	1878	Town,	
Malden,	–	–	– –	See Metropolitan Water District.
Manchester,	2,618	1892	Town,	Large well and tubular wells near Sawmill Brook; Gravel Pond, Hamilton.

[1] Town has voted to take works.

Table No. 1 — Continued.

City or Town.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Mansfield,	4,245	1888	Water supply district,	Large well near Pecuanticiot River.
Marblehead,	7,209	1885	Town,	Two large wells near Forest River.
Marion,	1,029	1908	Town,	Tubular wells near Benson's Brook.
Marlborough,	14,073	1883	City,	Lake Williams; storage reservoir on Millham Brook.
Marshfield,	1,763	1890	Private,	Large well.
Maynard,	5,811	1889	Town,	White Pond.
Medfield,	3,314	1889	Private,	Spring.
Medford,	–	–	– –	See Metropolitan Water District.
Melrose,	–	–	– –	See Metropolitan Water District.
Merrimac,	1,884	1904	Town,	Tubular wells near Kimballs Pond.
Methuen,	8,676	1875	Town,	Tubular wells near Spicket River.
Middleborough,	6,888	1885	Fire district,	Large well near Nemasket River.
Middleton,	–	–	– –	See Danvers.
Milford,	12,105	1881	Private,	Charles River filtered; large wells.
Hopedale,	2,048	1881	Private,	
Millbury,	4,631	1895	Private,	Large well.
Millis,	1,252	1891	Town,	Spring.
Milton,	–	–	– –	See Metropolitan Water District.
Monson,	4,344	1895	Town,	Large well.
Montague,	7,015	1887	Fire and water supply districts.	Lake Pleasant.
Erving,	1,094	1896	Water supply district,	
Nahant,	–	–	– –	See Metropolitan Water District.
Nantucket,	2,930	1878	Private,	Wannacomet Pond; wells near pond.
Natick,	9,609	1874	Town,	Large well near Lake Cochituate.
Needham,	4,284	1890	Town,	Large well; tubular wells.
New Bedford,	74,362	1869	City,	Great Quittacas Pond, Little Quittacas Pond, Lakeville.
Newburyport,	14,675	1881	City,	Large wells; springs; Artichoke River.
Newton,	36,827	1876	City,	Filter conduit and tubular wells near Charles River, Needham.
North Adams,	22,150	1861	City,	Storage reservoir on Notch Brook; Broad Brook, Pownal, Vt.
Northampton,	19,957	1871	City,	Storage reservoir on Roberts Meadow Brook; West Brook; Mountain Street Reservoir.
North Andover,	4,614	1898	Town,	Great Pond.
North Attleborough,	7,878	1884	Town,	Large wells near Ten Mile River.
Northborough,	1,947	1882	Town,	Storage reservoirs on Cold Harbor Brook, Boylston and Shrewsbury.
Northbridge,	7,400	1889	Private,	Storage reservoir on Cook Allen Brook, Sutton; springs.

Table No. 1 — Continued.

CITY OR TOWN.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
North Brookfield,	2,617	1893	Town,	Doane and North ponds.
Northfield,	2,017	1900	Private,	Storage reservoirs.
Norwood,	6,731	1885	Town,	Buckmaster Pond, Westwood.
Oak Bluffs,	1,138	1890	Private,	Springs.
Orange,	5,578	1873	Town,	Spring; Coolidge Brook.
Oxford,	2,927	1906	Private,	Tubular wells near Kidder Brook.
Palmer,	7,755	1886	Private,	Storage reservoir and tubular wells.
Peabody,	13,098	1799	Town,	Brown's Pond; Spring Pond, Lynn, Salem and Peabody; Suntaug Lake, Lynnfield.
Pepperell,	3,268	1909	Town,	Tubular wells near Gulf Brook.
Pittsfield,	25,001	1855	City,	Ashley Lake and Ashley Brook, Washington; Sacket and Hathaway brooks, Dalton; Mill Brook, Washington; Onota Lake.
Plainville,	1,300	1909	Town,	Tubular wells near Ten Mile River.
Plymouth,	11,119	1855	Town,	Little South Pond; Great South Pond; Lout Pond; Boot Pond.
Provincetown,	4,362	1893	Town,	Tubular wells.
Quincy,	–	–	– –	See Metropolitan Water District.
Randolph,	4,034	1888	Town,	Great Pond, Randolph and Braintree (used also by Braintree).
Holbrook,	2,509	1888	Town,	
Reading,	5,682	1891	Town,	Filter gallery near Ipswich River, filtered.
Revere,	–	–	– –	See Metropolitan Water District.
Rockland,	–	–	– –	See Abington.
Rockport,	4,447	1895	Town,	Cape Pond.
Rutland,	1,713	1896	Town,	Muschopauge Lake (used also by Holden).
Salem,	37,627	1868	City,	Wenham Lake, Longham Reservoir, Beverly and Wenham.
Beverly,	15,223	1868	City,	
Saugus,	–	–	– –	See Lynn.
Scituate,	2,597	1901	Private,	Tubular wells.
Sharon,	2,085	1885	Town,	Large well; tubular wells near Beaver Brook.
Sheffield,	1,782	1897	Private,	Springs.
Shelburne,	1,515	1885	Private,	Springs.
Shirley,	1,692	1903	Water supply district,	Large well.
Somerville,	–	–	– –	See Metropolitan Water District.
Southbridge,	11,000	1880	Private,	Storage reservoirs on Hatchet Brook; two reservoirs on small brook.
South Hadley,	5,054	1872	Fire district,	Storage reservoir on Buttery Brook; storage reservoir on Leaping Well Brook.

Table No. 1 — Continued.

City or Town.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Spencer,	7,121	1883	Town,	Shaw Pond, Leicester.
Springfield,	73,540	1874	City,	Ludlow Reservoir, Ludlow; Jabish and Axe Factory brooks; Broad Brook, Belchertown; Chapin Pond and Higher Brook, Ludlow; Five Mile Pond.
Ludlow,	3,881	1873	Private,	
Stockbridge,	2,022	1862	Private,	Lake Averic.
Stoneham,	–	–	–	See Metropolitan Water District.
Stoughton,	5,959	1886	Town,	Muddy Pond Brook.
Sunderland,	910	1883	Private,	Springs.
Swampscott,	–	–	–	See Metropolitan Water District.
Taunton,	30,967	1876	City,	Assawompsett and Elder's ponds, Lakeville.
Tisbury,	1,120	1887	Town,	Large well.
Uxbridge,	3,881	1879	Town,	Springs; tubular wells near West River.
Wakefield,	10,268	1883	Town,	Crystal Lake.
Walpole,	4,003	1896	Town,	Tubular wells near Lowe Brook.
Waltham,	26,282	1873	City,	Large wells near Charles River.
Ware,	8,594	1886	Town,	Large well and tubular wells near Meadow Brook.
Wareham,	3,660	1894 1908	Private, Fire district,	Jonathan Pond. Tubular wells near Mosquito Brook.
Warren,	4,300	1837	Private,	Springs.
Watertown,	–	–	–	See Metropolitan Water District.
Wayland,	2,220	1878	Town,	Storage reservoir on Snake Brook.
Webster,	10,018	1881	Town,	Large well and tubular wells near Lake Chaubunagungamaug.
Wellesley,	6,189	1884	Town,	Large well; filter gallery; tubular wells near Rosemary Brook.
Westborough,	5,378	1879	Town,	Storage reservoir; filter basin.
West Brookfield,	1,384	1838	Private,	Springs.
Westfield,	13,611	1874	Town,	Moose Meadow Brook, Montgomery; Tillotson Brook, Granville.
Westford,	2,413	1908	Private,	Tubular wells near Stony Brook.
Weston,	2,091	1896	Private,	Large well and tubular wells.
West Springfield,	8,101	1875	Town,	Storage reservoir on Darby Brook; large well; Bear Hole Brook, filtered.
West Stockbridge,	1,023	1873	Private,	Springs.
Weymouth,	11,585	1885	Town,	Great Pond.
Whitman,	–	–	–	See Brockton.
Williamsburg,	1,943	1903	Town,	Unquomonk Brook.
Williamstown,	4,425	1859	Private,	Cold Spring; Sherman Spring; Rattlesnake Brook, Pownal, Vt.

Table No. 1 — Concluded.

City or Town.	Population in 1905.	Date of Introduction of Water.	Ownership of Works.	Sources of Supply.
Winchendon, . . .	5,933	1896	Town, ...	Large well.
Winchester, . . .	8,242	1873	Town, ...	Three storage reservoirs.
Winthrop, . . .	–	–	– –	See Metropolitan Water District.
Woburn, . . .	14,402	1873	City, ...	Filter gallery, large well and tubular wells near Horn Pond.
Worcester, . . .	128,135	1845	City, ...	Two reservoirs on Tatnuck Brook, Holden; storage reservoir on Lynde Brook, Leicester; four reservoirs on Kettle Brook, Leicester.
Wrentham, . . .	1,428	1908	Town, ...	Tubular wells.

Description of New Water Works and of Changes in Older Works since 1906.

Avon.

The works are owned by the town, and water was first introduced in 1890, the source of supply being a large well 20 feet in diameter and 22 feet in depth, located on the site of Porters Spring, about three-quarters of a mile south of the center of the town. In 1908–09, two tubular wells 8 inches in diameter were driven at distances of 250 and 450 feet northeast of the large well, to depths of 225 and 201 feet respectively. Water is pumped from these wells into the large well, and, together with the water of that well, is pumped directly into the mains, the surplus going to a standpipe.

Bedford.

The works are owned by the town, and water was first introduced in 1909, the source of supply being a large well and filter located in the valley of Kenrick Brook, a small tributary of the Shawsheen River, in the easterly part of the town near the boundary line between Bedford and Lexington. The well is 20 feet in diameter and 21 feet in depth below the surface of the filter, which surrounds it. The filter, which is of sand, — uncovered, — has a filtering area of about 8,800 square feet, and is to be used only when the amount of water obtainable from the well is insufficient for the supply of the town. The water applied to the filter is obtained by gravity from a reservoir having a capacity of about 3,000,000 gallons, formed by a dam on Kenrick Brook about 130 feet above the well. The water is pumped from the well directly into the mains, the excess going to a covered standpipe, thus delivering the water to the consumers without exposure to light.

Blandford (Blandford Fire District).

Works for the supply of the Blandford Fire District were constructed by the district in 1909. The source of supply is the south branch of Freeland Brook, upon which a small reservoir, having a capacity of about 75,000 gallons, has been constructed in a ravine about half a mile north of the main village. The water is pumped from the reservoir to a distributing reservoir located about a third of a mile distant, and thence distributed to the district. This distributing reservoir is of concrete, with a capacity of about 200,000 gallons, and is covered with a wooden roof to exclude the light. This latter precaution was deemed advisable because the flow of this brook in the summer months is derived largely from springs, and the quality of the water would be likely to deteriorate if exposed to the light in an open reservoir.

Brookfield.

Water was introduced by the town into the main village of Brookfield in 1889, the source of supply being a small storage reservoir located in the southerly part of the town of North Brookfield. During very dry periods the amount of water obtainable from this reservoir is not sufficient for the needs of the village, and at such times water is pumped directly from the Quaboag River. In 1909 water was introduced into the village of East Brookfield. The works were constructed by the town, and the source of supply is a system of tubular wells located on the westerly shore of Lake Lashaway, about half a mile from the center of the village. The system consists of twelve tubular wells, 2½ inches in diameter and varying in depth from 19 to 24 feet. The water is pumped from the wells directly into the mains, the surplus going to a covered standpipe.

Chelmsford (North Chelmsford Fire District).

The works are owned by the district, and water was first introduced in 1907, the source of supply being a system of ten tubular wells, 2½ inches in diameter and varying in depth from 23 to 30 feet, located on the easterly shore of Crystal Lake, about a third of a mile from the center of the village. The supply was increased in 1908 by the installation of ten additional wells, also 2½ inches in diameter and varying in depth from 20 to 35 feet, located near the original wells. The water is pumped from the wells directly into the mains, the surplus going to a covered standpipe located near the pumping station.

Cohasset.

The works are owned by the Cohasset Water Company, and water was first introduced into the town in 1886. The original source of supply was a system of tubular wells, 2 inches in diameter and varying in depth from 25 to 40 feet, located in the valley of a small brook southwest of and very close to the main village. In 1898 an additional supply was obtained from a system of tubular wells, 2½ inches in diameter and varying in depth from 22 to 38 feet, located in Ellms Meadow, so called, a short distance south of the Cohasset station. In 1902 the supply was still further increased by the construction of a filter gallery on the northerly shore of Lily Pond, about a mile southwest of the main village. In 1909 a large well, 25 feet in diameter and 25 feet in depth, was constructed in the valley of Bound Brook, just north of the village of Beechwood. The yield of this well is increased somewhat by filtering the water of Bound Brook through two sand filters having a total filtering area of about 5,000 square feet, located about 100 feet from the well. The water of both systems of tubular wells is affected to some extent by the population upon the area drained by the wells, and that of the original system is also affected by the presence of an excessive quantity of iron. The water of the filter gallery at Lily Pond contains a very large amount of organic matter and much iron, due to the imperfect filtration of water from Lily Pond into the filter gallery. The water of the new large well contains an amount of iron sufficient at times to make it objectionable for some domestic purposes. An open distributing reservoir is still used in connection with these works, and as a result of exposure to light the water deteriorates, and is affected at times by the presence of considerable numbers of microscopic organisms.

Concord and Lincoln.

Water was introduced into Concord by the town in 1873 and into Lincoln by that town in 1874, the source of supply being Sandy Pond, in Lincoln. The statute under which water was taken provides that, if the water of the pond shall prove insufficient for the supply of both towns, the town of Lincoln shall be first supplied. The water in Sandy Pond has been gradually drawn down, reaching a very low level in the latter part of the year 1908, and in 1909 the town of Concord introduced an additional supply of water from Nagog Pond, in Acton. Nagog Pond has an area of 265 acres and a watershed area, including the area of the pond, of 1.75 square miles. The water of this pond is similar in quality to that of Sandy Pond.

Easthampton.

The works are owned by the town, and water was first introduced in 1870, the source of supply being a storage reservoir built in 1847 on a small stream which flows into Williston Pond. In 1892 this source was abandoned and water was taken from a small storage reservoir constructed on Bassett Brook, in the northwesterly part of the town. During dry periods the amount of water obtainable from this source was insufficient for the supply of the town, and at such times water was drawn directly from the Manhan River. The water of both of these sources is affected unfavorably by the drainage from a considerable population upon their watersheds, and on Aug. 1, 1907, the State Board of Health called the attention of the Easthampton authorities to the danger to the health of those using the water from these sources. In 1909, in accordance with the advice of the Board, works were constructed for obtaining a supply of water from the ground in the valley of Broad Brook, at the foot of the westerly slope of Mt. Tom, in the southeasterly part of the town. These works consist of twenty-seven tubular wells, 2½ inches in diameter and varying in depth from 35 to 50 feet. Water is pumped from these wells directly into the mains, the surplus going to the distributing reservoir which was used in connection with the former source of supply, but which is now being reconstructed and covered to exclude the light.

Huntington (Huntington Fire District).

The works are owned by the fire district, and water was first introduced in 1899, the source of supply being Cold Brook, upon which a small storage reservoir has been constructed. This brook has a watershed area of about 0.97 of a square mile which is very sparsely populated. The amount of water obtainable from this source is insufficient for the needs of the town in the drier portions of the year, and in 1908 nine tubular wells, varying in depth from 19 to 37 feet, were driven in the sandy plain on the southerly side of and about 400 feet from the Westfield River. Water is pumped from these wells directly into the mains, the surplus going to Cold Brook Reservoir.

Lenox.

The Aspinwall Hotel and a very small portion of the town of Lenox are supplied with water by the Aspinwall Water Company, but the greater portion of the town is supplied by the Lenox Water Company, which introduced water into the town in 1875. The sources of supply

of the company are three small reservoirs in the mountains west of the village. In 1908 sufficient water for the needs of the town could not be obtained from these sources, and with the consent of the Board water was taken temporarily from Laurel Lake, in the town of Lee. While the reservoirs were drawn down in 1908 the dam at the upper Root Reservoir, so called, was raised and the storage capacity greatly increased, so that it has not been necessary to draw water from Laurel Lake during the year 1909.

Manchester.

The works are owned by the town, and water was first introduced in 1892. The original source of supply was a large well, 32 feet in diameter and 29 feet in depth, in the bottom of which five 2½-inch tubular wells were driven to a further depth of 22 feet. In 1893 six additional wells, 4 inches in diameter, were driven in the bottom of the large well to about the same depth as the other wells. These works are located in the valley of Sawmill Brook, a short distance northeast of the main village of Manchester. In 1895 a supplementary plant, consisting of five 4-inch tubular wells, varying in depth from 27 to 54 feet, was constructed at Coolidge Spring, so called, near Sawmill Brook, about 500 feet from the large well. In 1901 twenty 3-inch tubular wells were added, all of which are within 250 feet of the large well. In 1909 works were completed for taking water from Gravel Pond, in the town of Hamilton. This pond has an area of 46 acres, and a drainage area, including the area of the pond, of about 126 acres. Its watershed is uninhabited.

Marblehead.

The works are owned by the town and water was first introduced in 1885. The present sources of supply are two large wells located near Loring Avenue, in the city of Salem, not far from Forest River, which is a tidal stream bordered by salt marshes. Well No. 1, which is situated near Loring Avenue, was constructed in 1890, and is 30 feet in diameter and 31.5 feet deep. Well No. 2 was constructed in 1895, and is 25 feet in diameter and 33.5 feet deep. The latter well is situated about 590 feet east of well No. 1, in the bed of a pond which has been drained, and was dug through about 20 feet of mud into a stratum of gravel. A group of tubular wells in the valley of Forest River, below well No. 1, was used for a time in connection with the large wells, but the water became affected by the salt water to such an extent that the use of the wells had to be discontinued. The water obtained from well No. 2 has for several years been very unsatisfactory, chiefly on account of the presence of excessive quantities of iron, and in 1909 works were constructed for the

removal of the iron from the water. These works consist of an aerating chamber through which the water passes to a sedimentation basin and thence to two covered sand filters, each having an area of 0.10 of an acre. From these filters the water flows to well No. 1, and, together with the water of that well, is pumped into the distributing system, the surplus going to a standpipe.

Marion.

The works are owned by the town, and water was first introduced in 1908, the source of supply being a system of sixteen tubular wells, 2½ inches in diameter and varying in depth from 24 to 29 feet, located in the valley of Benson's Brook, about 1¾ miles north of the center of the village. Water is pumped from these wells into the distributing system, the surplus going to a standpipe located about half a mile west of the village.

Montague and Erving.

Works were constructed in 1887 by the Turners Falls Fire District for supplying water from Lake Pleasant to the village of Turners Falls, in the town of Montague, and were extended to the village of Montague City, in that town, in 1901. The village of Millers Falls, located partly in Montague and partly in Erving, has been supplied with water from the Turners Falls works since 1896, by the Millers Falls Water Supply District. A large settlement on the shores of Lake Pleasant has been supplied with water taken from the Turners Falls works since 1908, by the Lake Pleasant Water Supply District. The source of water supply for all of these districts is Lake Pleasant, and the water is pumped by the Turners Falls Fire District. Lake Pleasant has an area of about 45 acres and a watershed of 1.78 square miles, which, except for the settlement of Lake Pleasant, contains a very small population. The water obtained from this pond is naturally of good quality, but is affected occasionally by the presence of microscopic organisms which impart to the water disagreeable tastes and odors.

Newburyport.

The works are owned by the city, and water was first introduced in 1881. The sources of supply are several springs and wells located on the southerly side of the Merrimack River, about 2½ miles from the center of the city. In 1908 works were constructed for taking water from the Artichoke River at a dam located on the river about 600 feet above its junction with the Merrimack River, from which water is pumped about 9,200 feet to two filtration areas, having a combined area of about

one acre, located in Jackman Ravine near Ferry Road. These areas were formed by removing the soil from the sandy lands near the head of the ravine. No underdrains are provided in these areas, the water being allowed to filter through the sand, and is collected below the filters and conducted through drains which also collect the natural flow in the Jackman Ravine into a collecting reservoir having a capacity of about 600,000 gallons. From this reservoir the water flows by gravity a distance of about 1,200 feet to the pumping station. In the winter months the water is not applied to the filtration areas, but is turned into one or all of four lines of 8-inch vitrified pipe, aggregating 4,800 feet in length, laid with open joints, at a depth of 4 feet, around the slopes of the ravine just outside the filtration areas. The water from this system of pipes, after passing through the ground, is collected by the same system of pipes that collects the water from the filtration areas. The water from all of the sources is pumped directly into the mains, the surplus going to a covered standpipe.

Newton.

The works are owned by the city, and water was first introduced in 1876. The original source of supply was a filter basin 1,575 feet in length, located on the westerly side of the Charles River, in the town of Needham, above the village of Newton Upper Falls. In 1890 a covered filtering conduit of wood, 4 feet square, was laid through this filter basin, and extended southerly along the westerly bank of the river to Kendrick Street, a total distance of about 3,700 feet. This conduit is at no point farther from the river than 300 feet, and is laid level throughout its entire length, with its bottom about 10 feet below the normal elevation of the water in the river. At intervals along its length tubular wells 2½ inches in diameter have been driven in pairs, one on either side, and are connected with and discharge into the conduit. In 1894 an extension was constructed from the upper end of the wooden conduit at Kendrick Street westward from the river along the foot of a ridge for a distance of about 3,000 feet, with a slope of about 1 foot in the entire distance. This extension is a double line of 24-inch tile pipe, laid with open joints, and tubular wells are connected with it wherever the conduit was laid through soil that did not yield water freely. In 1908–09 another extension was made, in a generally southerly direction, parallel with and at a maximum distance of about 350 feet from the river. This conduit is of concrete, 30 inches in diameter, and in the trench with it and at a slightly lower level a 12-inch pipe was laid, with which tubular wells are connected and from which there are connections into the conduit at frequent intervals. At the close of the year about 1,400 feet of this conduit, which will

eventually extend to Hardy Street, — a distance of about 3,600 feet, — had been completed. From this conduit the water flows to the pumping station, where it is pumped into a covered distributing reservoir located on Waban Hill.

Palmer.

Water was introduced into the main village of Palmer in 1886 by the Palmer Water Company, which still controls the works. The source of supply is a small brook in Palmer upon which two storage reservoirs have been constructed. The upper of these two reservoirs has an area of about 4 acres and a capacity of about 6,000,000 gallons. The lower reservoir, which is situated a short distance below the upper one, has an area of ¾ of an acre and a capacity of about 2,000,000 gallons. Water is drawn from the lower reservoir and supplied to the town by gravity. In 1908 the Boston Duck Company introduced a supply of water into the village of Bondsville, in Palmer, from six tubular wells, 2½ inches in diameter and varying in depth from 18 to 48 feet, located on the easterly side of Jabish Brook, about half a mile above its mouth in the town of Belchertown. In connection with these works a covered concrete standpipe, having a capacity of about 600,000 gallons, was constructed, and during the hours of pumping the excess over consumption is stored in this standpipe.

Pepperell.

A water supply was introduced by the town in 1909. The source of supply is a system of 34 tubular wells, 2½ inches in diameter and varying in depth from 19 to 27 feet, located a short distance south of the New Hampshire line, on the easterly side of Gulf Brook, a tributary of the Nissitissit River. Water is pumped from the wells directly into the mains, the surplus going to a covered standpipe located on Masons Hill, about half a mile southwest of the main village.

Plainville.

The works are owned by the town, and water was first introduced in 1909, the source of supply being a small system of tubular wells, 2½ inches in diameter, located on the westerly side of Ten Mile River, about a quarter of a mile northwest of the center of the town. Water is pumped from the wells directly into the mains, the surplus going to a covered standpipe located on Bacon Hill, about half a mile from the center of the village.

Provincetown.

Water was introduced by the town in 1893, the source of supply being a system of six 5-inch tubular wells, driven in loose, sandy soil to an average depth of about 28 feet. The water obtained from these wells

contained a very large amount of iron, and early in 1898 a large open basin to collect the water from the ground was constructed and the further use of the tubular wells discontinued. The amount of iron in the water of the large basin increased steadily, and in 1906 experiments were made with a view to removing the iron from this water by some process of filtration. Investigations were also made with a view to obtaining a supply of water from the ground in the vicinity of North Truro. The results of these experiments and investigations were submitted to the Board, who advised that works be constructed for obtaining a supply of water from the ground in North Truro, and in accordance with this advice works were constructed there in 1908. These works consist of twenty tubular wells, 2½ inches in diameter and having an average depth of about 30 feet. The water is pumped from these wells a distance of about 4 miles directly into the distributing system, the surplus going to a covered standpipe.

Southbridge.

The works are owned by the Southbridge Water Company, and water was first introduced in 1880. The sources of supply are two small reservoirs, known as Nos. 1 and 2, situated on a very small stream in the southerly part of the village, and two large reservoirs, known as Nos. 3 and 4, situated on Hatchet Brook in the southerly part of the town. Reservoir No. 1 has an area of 5 acres and a capacity of about 9,000,000 gallons; No. 2, an area of 3.5 acres and a capacity of about 12,000,000 gallons; No. 3, an area of 22 acres and a capacity of 85,000,000 gallons, and No. 4, an area of 67 acres and a capacity of 185,000,000 gallons. Reservoirs Nos. 1, 2 and 3 are used only in emergencies, and the supply of the town is ordinarily drawn by gravity from Reservoir No. 4. The water of Hatchet Brook is naturally of good quality, but the soil and organic matter were not removed from the area flooded by the construction of Reservoir No. 4, and as a result during the summer and fall months the water is objectionable on account of the quantity of organic matter present.

In 1908 works were constructed for the purpose of removing the organic matter from the water of this reservoir. These works consist of three open sand filters, having a combined area of about 0.20 of an acre, upon which the water is delivered by gravity. The water is thoroughly aerated before and after filtration, and is collected in a collecting basin from which it is delivered into the distributing mains.

Uxbridge.

Water was introduced into the main village of Uxbridge in 1879 by the Uxbridge Water Company, the sources of supply being several springs, the water of which was collected by drains and stored in two small storage reservoirs and thence distributed to the consumers by gravity. Subsequently these works were purchased by the town, and are still in use for the supply of a portion of the main village. The quantity of water obtainable from these sources becoming insufficient for the supply of the village, works were constructed in 1906 for an additional supply, and also for the supply of the remainder of the town, the water being obtained from the ground on the east side of West River, about 1 mile east of the main village. These works consist of a system of sixteen tubular wells, 2½ inches in diameter and varying in depth from 26 to 35 feet, from which water is pumped directly into the mains, the surplus going to a covered standpipe located about 1 mile west of the main village.

Waltham.

The works are owned by the city, and water was first introduced in 1873. The original source of supply was a filter basin, irregular in shape and covering an area of about a quarter of an acre, located on the northerly side of the Charles River, about 1¼ miles from the center of the city. In 1891 a large well, 40 feet in diameter, was sunk in the bottom of this basin to a depth of 18 feet below the floor of the basin, or 26.4 feet below mean level of the water in the river. In 1908 the supply was still further increased by the construction of a large well, 30 feet in diameter, about 3,600 feet west of the original filter basin. This new well is located on the site of a small pond, having an area of about 1 acre, from which all of the water was drawn off and the mud in the bottom replaced with clean gravel. The bottom of this well is 29.4 feet below the mean level of the water in the river. Water from the old and new wells is pumped directly into the mains, the surplus going to a covered concrete standpipe constructed in 1906.

Wareham.

Water was introduced into the village of Onset, in the town of Wareham, by the Onset Water Company in 1894, the source of supply being Jonathan Pond. This pond is located about 3½ miles west of the main village of Wareham and has an area of about 16 acres. In 1908 the Wareham Fire District constructed works for the supply of that district. The source of supply is a system of twelve tubular wells, 2½ inches in

diameter and having an average depth of 39 feet, located in the valley of Mosquito Brook, near the village of Tihonet, about 2 miles north of the main village of Wareham. Water is pumped from these wells directly into the mains, the surplus going to a covered standpipe.

Webster.

The works are owned by the town, and water was first introduced in 1881, the original source of supply being a large well, 25 feet in diameter and 30 feet in depth, located on the westerly shore of Lake Chaubunagungamaug, about a mile east of the center of the town. In 1903 the supply was increased by the installation of a system of twenty-six tubular wells, 2½ inches in diameter and varying in depth from 35 to 65 feet, located between 300 and 650 feet from the large well. In 1909 the supply was still further increased by the installation of a system of fourteen tubular wells, 6 inches in diameter, located about 550 feet from the large well. The water from all of the tubular wells flows by gravity into the large well, from which it is pumped directly into the mains, the surplus going to a standpipe.

Westford.

The works are owned by the Westford Water Company, and water was first introduced into the town in 1908. The source of supply is a system of ten tubular wells, 2½ inches in diameter and having an average depth of about 35 feet, located on the easterly side of Stony Brook, about midway between the villages of Graniteville and Forge Village, in the extreme westerly part of the town. Water is pumped from the wells directly into the mains, the surplus going to two standpipes, — neither of which is covered, — one located on Prospect Hill, near the main village of Westford, and the other on Town Farm Hill, just north of Forge Village.

West Springfield.

The works are owned by the town, and water was first introduced in 1875. The original source of supply was Darby Brook, in West Springfield, on which a small storage reservoir, having an area of 3.5 acres and a capacity of about 10,000,000 gallons, was built. A large well, 25 feet in diameter and 14 feet deep, was constructed in 1893 in the valley of Darby Brook just below the storage reservoir. Water was supplied by gravity from the reservoir to the lower portions of the town, while the high-service supply was drawn from the well and pumped to a standpipe. In 1906–07 works were constructed for taking water from Bear Hole Brook, in the extreme westerly part of the town, about 4 miles from the main village. These works consist of a small collecting reservoir and

pumping station, together with an open filter having an area of $\frac{1}{3}$ of an acre. The water of Bear Hole Brook, after filtration, is pumped about $1\frac{1}{4}$ miles to a standpipe, and thence supplies both the high and low service portions of the town.

Woburn.

The works are owned by the city, and water was first introduced in 1873, the original source of supply being a filter gallery located on the southerly shore of Horn Pond. This filter gallery is about 130 feet from the shore of the pond, is 82 feet long and 12 feet wide, and its bottom is about 8 feet below high water in the pond. In 1908 a large well, 20 feet in diameter and 30 feet in depth, with its bottom about 12 feet below the bottom of the filter gallery, was constructed about 100 feet south of the filter gallery.

In 1909 fifty tubular wells, $2\frac{1}{2}$ inches in diameter with an average depth of about 45 feet, were driven on the westerly shore of Horn Pond, about 1,200 feet northwest of the pumping station, and the water from these wells is discharged into the new large well. Water is pumped directly into the distributing system from the new well and the filter gallery, and during the hours of pumping the excess over consumption is stored in a large uncovered reservoir.

Wrentham.

The works are owned by the town, and water was introduced in 1908. The source of supply is a system of ten tubular wells, $2\frac{1}{2}$ inches in diameter and having an average depth of about 29 feet, located at the upper end of the so-called Trout Ponds, about 1 mile south of the center of the main village. The water is pumped from these wells directly into the mains, the surplus going to a covered standpipe.

Comparison of Different Waters by Chemical Analysis.

In presenting a comparison of the different waters it is necessary to take into account differences in the physical characteristics of the various sources. Although surface waters (those of lakes, ponds and streams) and ground waters (those of wells, filter galleries, springs, etc.) have a common origin in the rain, they present upon examination such essential differences in character that in comparing the quality of the waters of the different sources these two classes will be considered separately.

Surface-water Supplies.

As there are essential differences between surface and ground waters, there are also important differences in the physical characteristics of surface-water sources which affect very materially the quality of such waters. The waters of running streams under normal conditions contain but little organic life; but their waters take up the products of decaying organic matter from the grasses, leaves and soil with which they come in contact, and a greater or less quantity of mineral matter is also dissolved from the soil and rocks over which the waters flow. In ponds and storage reservoirs, on the other hand, vegetable and animal organisms find conditions more favorable to their growth and development, and the extent of such growths and their effect upon the quality of the water differs greatly in different sources. It is of interest to compare, also, the quality of the waters of natural ponds and lakes with that of the waters of artificial reservoirs, and subdivisions have been made in the tables so as to facilitate such comparisons.

The averages of all of the analyses of the various surface-water supplies made during the past five years have been calculated, and are presented in the following table.

In this table the analyses of the waters of the metropolitan sources are placed at the beginning, and the others follow in alphabetical order by towns.

In the case of most of the waters the results given in the table are the average of from thirty to sixty analyses, made at regular intervals of one or two months. In a few cases the samples have been collected at longer intervals, but nearly always as often as once in three months, and in a few cases samples have been collected as often as once in two weeks or less.

The use of some of the sources included in the table was begun less than five years ago, and the examinations have consequently covered a shorter period than five years. These cases are mentioned in the notes following the table.

TABLE No. 2. — *Averages of Chemical Analyses, from 1905 to 1909, inclusive.*

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Metropolitan Water District.	Wachusett Reservoir,[1]	.18	3.03	.0022	.0136	.0025	.25	.0024	.0001	.31	0.8
	Sudbury Reservoir,	.19	3.32	.0032	.0140	.0024	.28	.0044	.0001	.31	1.1
	Framingham Reservoir No. 3.	.18	3.32	.0026	.0148	.0031	.28	.0040	.0001	.31	1.1
	Hopkinton Reservoir,	.57	3.99	.0029	.0178	.0022	.36	.0042	.0001	.66	0.9
	Ashland Reservoir,	.60	3.94	.0024	.0197	.0024	.30	.0027	.0001	.70	0.9
	Framingham Reservoir No. 2.	.69	4.34	.0031	.0212	.0024	.34	.0033	.0001	.76	1.0
	Lake Cochituate,	.24	5.21	.0029	.0221	.0049	.54	.0027	.0001	.42	2.0
	Chestnut Hill Reservoir,	.21	3.49	.0024	.0146	.0028	.29	.0048	.0001	.31	1.1
	Weston Reservoir,	.17	3.51	.0020	.0128	.0021	.29	.0053	.0002	.28	1.2
	Spot Pond,	.13	3.49	.0019	.0148	.0023	.33	.0017	.0000	.26	1.3
	Tap in State House,	.21	3.72	.0015	.0136	.0023	.33	.0066	.0001	.31	1.3
	Tap in Revere,	.12	3.61	.0014	.0127	.0016	.32	.0022	.0000	.25	1.3
	Tap in Quincy,	.18	3.68	.0014	.0119	.0012	.33	.0076	.0001	.29	1.3
Abington,	Big Sandy Pond,	.10	3.17	.0025	.0156	.0020	.67	.0012	.0000	.19	0.5
Adams,	Bassett Brook,	.03	4.69	.0012	.0038	.0003	.10	.0077	.0001	.09	3.1
	Dry Brook,	.20	8.23	.0014	.0083	.0011	.13	.0050	.0001	.27	6.3
Amherst,	Amethyst Brook Reservoir.	.26	3.09	.0016	.0109	.0027	.14	.0023	.0000	.34	0.5
Andover,	Haggett's Pond,	.15	3.31	.0013	.0149	.0013	.33	.0015	.0000	.28	1.1
Ashfield,	Bear Swamp Brook,	.25	5.16	.0015	.0097	.0010	.10	.0021	.0000	.37	2.7
Athol,	Phillipston Reservoir,[1]	.57	3.45	.0096	.0408	.0158	.16	.0038	.0001	.66	0.5
	Buckman Brook Reservoir.	.30	3.29	.0033	.0232	.0076	.14	.0028	.0000	.47	0.6
Barre,	Reservoir,[1]	.18	3.08	.0028	.0197	.0042	.16	.0014	.0001	.29	0.9
Blandford,	Freeland Brook,[1]	.07	3.02	.0004	.0035	–	.14	.0137	.0060	–	0.7
Brockton,	Salisbury Brook Reservoir.[1]	.51	4.13	.0026	.0242	.0051	.44	.0013	.0000	.67	0.8
	Silver Lake,	.11	3.27	.0015	.0125	.0023	.62	.0009	.0000	.22	0.5
Cambridge,	Upper Hobbs Brook Reservoir.	.52	5.67	.0041	.0327	.0072	.42	.0067	.0001	.70	2.1
	Lower Hobbs Brook Reservoir.	.16	5.20	.0032	.0247	.0042	.41	.0025	.0001	.37	2.1
	Stony Brook Reservoir,	.39	5.70	.0030	.0213	.0027	.48	.0105	.0001	.53	2.1
	Fresh Pond,	.25	6.61	.0087	.0281	.0097	.60	.0145	.0005	.41	2.9
Cheshire,	Thunder Brook,	.06	5.69	.0011	.0043	.0007	.09	.0059	.0000	.10	3.8
	Kitchen Brook,	.03	5.03	.0008	.0034	.0007	.07	.0056	.0000	.08	3.7
Chester,	Austin Brook,	.12	3.50	.0010	.0057	.0004	.12	.0051	.0000	.16	1.4

[1] See notes.

TABLE No. 2. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Chicopee, . .	Morton Brook, . .	.08	4.02	.0011	.0044	.0009	.14	.0031	.0000	.10	0.8
	Cooley Brook, . .	.34	4.13	.0012	.0118	.0036	.18	.0032	.0001	.34	1.0
Concord, . .	Sandy Pond, . . .	.04	2.75	.0013	.0130	.0035	.29	.0019	.0000	.13	0.8
Dalton, . .	Egypt Brook Reservoir,	.32	3.24	.0024	.0113	.0020	.08	.0160	.0000	.45	1.0
Danvers, . .	Middleton Pond, . .	.52	4.19	.0018	.0186	.0023	.38	.0011	.0001	.66	1.2
Deerfield, . .	Roaring Brook, . .	.07	5.79	.0009	.0038	.0003	.10	.0092	.0000	.11	3.6
Easthampton, .	Bassett Brook,[1] . .	.30	4.22	.0014	.0105	.0018	.13	.0055	.0000	.35	1.3
Fall River, . .	North Watuppa Lake, .	.20	3.79	.0019	.0177	.0028	.60	.0018	.0000	.35	0.7
Falmouth, . .	Long Pond, . . .	.03	2.93	.0009	.0096	.0013	.93	.0010	.0000	.10	0.3
Fitchburg, . .	Scott Reservoir, . .	.17	2.68	.0049	.0179	.0049	.16	.0023	.0000	.31	0.4
	Meetinghouse Pond, .	.09	2.65	.0030	.0118	.0019	.15	.0018	.0000	.20	0.7
	Wachusett Lake,[1] . .	.13	2.52	.0025	.0142	.0031	.15	.0009	.0001	.22	0.4
Gardner, . .	Crystal Lake, . .	.09	4.41	.0024	.0167	.0022	.31	.0039	.0001	.21	1.6
Gloucester, . .	Dike's Brook Reservoir,	.41	4.09	.0029	.0172	.0031	.96	.0015	.0000	.40	0.3
	Wallace Reservoir, . .	.44	4.52	.0024	.0201	.0046	1.23	.0009	.0000	.46	0.4
	Haskell Brook Reservoir,	.53	4.29	.0095	.0157	.0025	.94	.0020	.0001	.40	0.4
Great Barrington,.	East Mountain Reservoir,	.11	5.34	.0040	.0086	.0020	.11	.0016	.0001	.19	3.6
	Green River, . . .	.02	9.41	.0013	.0034	.0005	.10	.0137	.0000	.07	7.3
Greenfield, . .	Glen Brook lower reservoir.	.07	5.36	.0025	.0077	.0016	.13	.0065	.0001	.12	3.0
	Glen Brook upper reservoir.[1]	.08	5.28	.0023	.0081	.0019	.14	.0056	.0001	.15	3.1
Hadley, . .	Hart's Brook Reservoir,[1]	.12	4.54	.0022	.0088	.0024	.17	.0007	.0000	.16	2.3
Hatfield, . .	Running Gutter Brook Reservoir.	.11	4.36	.0012	.0057	.0010	.15	.0175	.0000	.17	1.7
Haverhill, . .	Johnson's Pond, . .	.16	4.61	.0018	.0169	.0019	.40	.0016	.0001	.29	1.9
	Crystal Lake, . .	.20	3.33	.0019	.0161	.0018	.29	.0015	.0001	.33	1.0
	Kenoza Lake, . .	.16	4.07	.0022	.0160	.0023	.39	.0018	.0001	.31	1.7
	Lake Saltonstall, . .	.08	5.69	.0020	.0157	.0023	.56	.0014	.0001	.19	2.4
	Pentucket Lake, . .	.13	4.66	.0016	.0163	.0027	.53	.0010	.0001	.28	1.8
	Millvale Reservoir, .	.61	4.83	.0030	.0217	.0038	.34	.0020	.0001	.71	1.7
Hingham, . .	Accord Pond, . . .	.19	3.12	.0014	.0122	.0017	.64	.0011	.0000	.31	0.4
Holden, . .	Muschopauge Lake, .	.07	2.78	.0019	.0112	.0016	.25	.0033	.0000	.16	0.9
Holyoke, . .	Whiting Street Reservoir.	.11	4.35	.0040	.0231	.0068	.17	.0014	.0001	.22	2.3
	Fomer Reservoir, . .	.27	4.06	.0016	.0099	.0014	.14	.0030	.0001	.35	1.5

[1] See notes.

TABLE No. 2. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
				Free.	Albuminoid.			Nitrates.	Nitrites.		
					Total.	Suspended.					
Holyoke — *Con.*	Wright and Ashley Pond,	.10	5.13	.0044	.0198	.0035	.16	.0019	.0000	.23	2.7
	High Service Reservoir,[1]	.18	5.16	.0028	.0222	.0043	.17	.0028	.0001	.37	2.2
Hudson,	Gates Pond,	.12	2.81	.0028	.0153	.0028	.22	.0022	.0001	.22	0.7
	Fosgate Brook,	.44	4.69	.0040	.0115	.0011	.30	.0069	.0002	.47	1.5
Huntington,	Cold Brook,	.15	2.99	.0007	.0059	.0006	.12	.0014	.0000	.22	1.0
Ipswich,	Dow's Brook Reservoir,	.21	4.82	.0023	.0170	.0026	.66	.0031	.0001	.33	1.8
Lawrence,	Merrimack River filtered,	.36	–	.0047	.0097	–	.40	.0374	.0001	.36	1.4
Lee,	Codding Brook upper reservoir.	.27	2.57	.0042	.0203	.0040	.11	.0038	.0000	.41	0.7
	Codding Brook lower reservoir.	.20	3.53	.0026	.0104	.0012	.09	.0044	.0000	.29	1.6
	Basin Pond Brook,	.39	4.58	.0031	.0126	.0024	.11	.0043	.0000	.50	2.1
Lenox,	Reservoir,[1]	.09	7.12	.0018	.0117	.0023	.09	.0051	.0001	.15	5.1
Leominster,	Haynes Reservoir,	.22	2.68	.0076	.0310	.0088	.16	.0011	.0001	.36	0.2
	Morse Reservoir,	.20	2.45	.0032	.0189	.0038	.16	.0019	.0000	.30	0.2
	Fall Brook Reservoir,	.13	2.48	.0017	.0154	.0033	.16	.0009	.0000	.27	0.3
Longmeadow,	Cooley Brook,	.08	4.74	.0016	.0056	.0011	.19	.0266	.0001	.07	2.9
Lynn,	Birch Reservoir,	.35	4.35	.0058	.0230	.0047	.61	.0025	.0001	.47	1.4
	Breed's Reservoir,	.42	4.44	.0045	.0213	.0035	.61	.0027	.0001	.52	1.2
	Walden Reservoir,[1]	.45	4.82	.0071	.0235	.0040	.63	.0032	.0001	.59	1.6
	Hawkes Reservoir,	.55	5.66	.0049	.0258	.0033	.64	.0028	.0001	.70	1.9
	Saugus River,	.94	8.24	.0057	.0335	.0034	.80	.0027	.0001	1.07	3.7
Manchester,	Gravel Pond,[1]	.11	4.07	.0015	.0151	.0019	.81	.0004	.0000	.23	0.9
Marlborough,	Lake Williams,	.11	4.32	.0028	.0187	.0028	.51	.0018	.0001	.23	1.5
	Millham Brook Reservoir.	.49	4.43	.0043	.0224	.0046	.36	.0059	.0001	.51	1.3
Maynard,	White Pond,	.14	3.16	.0011	.0112	.0013	.30	.0051	.0000	.23	0.8
Milford,	Charles River filtered,[1]	.21	3.66	.0010	.0071	–	.31	.0155	.0000	.26	1.1
Montague,	Lake Pleasant,	.05	2.38	.0024	.0084	.0016	.13	.0022	.0000	.11	0.4
Nantucket,	Wannacomet Pond,	.09	6.18	.0026	.0169	.0055	2.12	.0010	.0000	.14	1.1
New Bedford,	Little Quittacas Pond,	.30	3.69	.0025	.0179	.0025	.55	.0008	.0000	.44	0.7
	Great Quittacas Pond,	.45	3.57	.0024	.0192	.0021	.56	.0006	.0000	.60	0.6
North Adams,	Notch Brook Reservoir,	.06	7.07	.0034	.0078	.0020	.08	.0021	.0003	.11	5.4
	Broad Brook,	.18	4.02	.0026	.0074	.0009	.08	.0126	.0000	.29	2.2
Northampton,	Middle Reservoir,	.27	4.22	.0020	.0127	.0024	.12	.0032	.0000	.35	1.6

[1] See notes.

TABLE No. 2. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Northampton—*Con.*	West Brook,	.13	4.51	.0008	.0054	.0008	.12	.0040	.0001	.17	1.8
	Mountain Street Reservoir.[1]	.10	3.82	.0012	.0088	.0019	.10	.0019	.0001	.18	1.7
North Andover,	Great Pond,	.15	3.72	.0023	.0176	.0022	.38	.0016	.0000	.29	1.4
Northborough,	Lower reservoir,	.64	4.07	.0043	.0232	.0046	.26	.0034	.0001	.66	0.9
Northbridge,	Cook Allen Reservoir,	.27	2.85	.0031	.0165	.0033	.19	.0013	.0000	.37	0.3
North Brookfield,	Doane Pond,	.49	3.18	.0050	.0233	.0049	.16	.0024	.0001	.46	0.5
	North Pond,	.49	3.03	.0060	.0312	.0098	.16	.0028	.0001	.58	0.5
Norwood,	Buckmaster Pond,	.14	3.79	.0110	.0162	.0039	.50	.0023	.0001	.19	1.0
Palmer,	Lower reservoir,	.25	3.42	.0025	.0154	.0038	.15	.0022	.0000	.29	0.7
Peabody,	Brown's Pond,	.16	3.71	.0020	.0163	.0030	.70	.0044	.0000	.27	0.9
	Spring Pond,	.09	6.49	.0081	.0127	.0027	.68	.0052	.0001	.17	2.3
	Suntaug Lake,[1]	.06	4.15	.0030	.0167	.0029	.72	.0025	.0001	.17	1.9
Pittsfield,	Ashley Lake,[1]	.30	4.84	.0031	.0168	.0020	.08	.0041	.0001	.45	2.6
	Ashley Brook,[1]	.19	5.63	.0028	.0125	.0017	.11	.0047	.0001	.30	4.2
	Hathaway Brook,	.04	10.23	.0007	.0048	.0006	.12	.0124	.0000	.12	9.2
	Mill Brook,	.15	5.21	.0009	.0069	.0008	.10	.0051	.0001	.23	3.9
	Sacket Brook,	.12	7.04	.0018	.0080	.0016	.12	.0115	.0000	.17	5.8
Plymouth,	Little South Pond,	.02	2.51	.0013	.0148	.0026	.67	.0007	.0000	.12	0.1
	Great South Pond,	.01	2.77	.0014	.0130	.0020	.66	.0003	.0000	.08	0.1
Randolph,	Great Pond,	.43	4.42	.0018	.0178	.0020	.67	.0039	.0001	.53	1.0
Rockport,	Cape Pond,	.26	9.38	.0074	.0326	.0122	3.20	.0017	.0001	.34	1.6
Salem,	Wenham Lake,	.24	5.79	.0064	.0218	.0051	.88	.0045	.0002	.38	2.1
	Longham Reservoir,	1.04	7.08	.0103	.0345	.0082	1.00	.0070	.0002	.96	1.9
Southbridge,	Hatchet Brook Reservoir No. 3.	.40	3.19	.0037	.0218	.0054	.17	.0021	.0000	.49	0.7
	Hatchet Brook Reservoir No. 4.[1]	.47	3.37	.0094	.0276	.0081	.20	.0011	.0001	.52	0.6
South Hadley,	Leaping Well Reservoir,	.10	2.84	.0063	.0222	.0092	.15	.0043	.0001	.14	0.7
	Buttery Brook Reservoir.	.17	3.85	.0066	.0117	.0036	.26	.0266	.0003	.17	0.8
Spencer,	Shaw Pond,	.08	2.84	.0025	.0151	.0013	.19	.0031	.0000	.17	0.9
Springfield,	Ludlow Canal,	.44	3.74	.0020	.0149	.0020	.17	.0032	.0001	.48	1.0
	Ludlow Reservoir,	.27	2.97	.0030	.0217	.0072	.15	.0019	.0001	.33	0.8
	Ludlow Basin,	.24	3.02	.0015	.0155	.0032	.15	.0014	.0000	.31	0.9
	Chapin Pond,	.06	2.34	.0025	.0189	.0044	.12	.0015	.0000	.19	0.4

[1] See notes.

TABLE No. 2. — *Averages of Chemical Analyses, etc.* — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Springfield — *Con.*	Loon Pond,	.05	2.99	.0020	.0185	.0032	.25	.0015	.0001	.16	0.8
	Five Mile Pond,	.10	2.55	.0042	.0182	.0028	.15	.0016	.0000	.20	0.4
Stockbridge,	Lake Averic,	.13	6.19	.0036	.0206	.0049	.09	.0025	.0001	.28	4.1
Stoughton,	Muddy Pond Brook,	.24	3.17	.0007	.0072	–	.36	.0044	.0000	.25	0.7
Taunton,	Assawompsett Pond,	.32	3.41	.0022	.0175	.0025	.54	.0012	.0000	.48	0.5
	Elder's Pond,	.11	3.04	.0015	.0157	.0021	.52	.0009	.0000	.29	0.5
Wakefield,	Crystal Lake,	.20	4.80	.0041	.0191	.0038	.63	.0051	.0001	.31	1.8
Wareham,	Jonathan Pond,	.01	2.35	.0011	.0083	.0012	.67	.0013	.0000	.08	0.0
Wayland,	Snake Brook Reservoir,	.73	4.78	.0056	.0239	.0039	.33	.0089	.0001	.69	1.5
Westfield,	Montgomery Reservoir,	.42	2.64	.0041	.0210	.0049	.13	.0015	.0000	.53	0.3
	Tillotson Brook Reservoir.	.18	3.08	.0021	.0083	.0015	.15	.0026	.0001	.24	0.5
	Tekoa Reservoir,	.38	2.81	.0024	.0149	.0024	.14	.0016	.0001	.47	0.3
West Springfield,	Darby Brook Reservoir,	.22	4.89	.0066	.0151	.0061	.23	.0070	.0001	.26	2.3
	Bear Hole Brook filtered,[1]	.06	6.77	.0009	.0043	–	.18	.0036	.0000	–	4.0
Weymouth,	Great Pond,	.68	4.19	.0032	.0174	.0020	.57	.0022	.0000	.71	0.5
Williamsburg,	Reservoir,	.21	3.82	.0027	.0080	.0011	.12	.0016	.0000	.23	1.5
Winchester,	North Reservoir,	.09	3.93	.0041	.0186	.0034	.44	.0014	.0001	.22	1.6
	South Reservoir,	.14	3.51	.0068	.0175	.0025	.38	.0021	.0001	.23	1.2
	Middle Reservoir,	.16	3.67	.0070	.0278	.0063	.40	.0019	.0001	.32	1.3
Worcester,	Bottomly Reservoir,	.27	3.76	.0031	.0190	.0030	.23	.0108	.0001	.45	1.1
	Kent Reservoir,	.17	3.38	.0017	.0155	.0030	.21	.0059	.0001	.31	1.1
	Leicester Reservoir,	.20	3.14	.0038	.0138	.0019	.21	.0043	.0001	.31	0.9
	Mann Reservoir,	.19	3.74	.0017	.0148	.0032	.22	.0062	.0001	.33	1.1
	Upper Holden Reservoir,	.15	2.42	.0020	.0125	.0025	.18	.0020	.0000	.24	0.4
	Lower Holden Reservoir,	.09	2.42	.0019	.0122	.0022	.19	.0020	.0001	.19	0.6

[1] See Notes.

NOTES.

Metropolitan Water District, Wachusett Reservoir. — The water of this reservoir may have been unfavorably affected by the operations incident to its construction during the first year or two of the period covered by the analyses.

Athol, Phillipston Reservoir. — The water of this reservoir is filtered through a mechanical filter before being supplied to the town.

Barre, Reservoir. — Much of the water which enters this reservoir is ground water, which deteriorates rapidly upon exposure to light.

Blandford, Freeland Brook. — This brook, the water of which is derived largely from springs, was first used in 1909.

Brockton, Salisbury Brook Reservoir. — The water of this reservoir has not been used since the introduction of water from Silver Lake, in 1904.

Easthampton, Bassett Brook. — The use of this source was discontinued in 1909.

Fitchburg, Wachusett Lake. — This source was first used in 1907.

Greenfield, Glen Brook Reservoir (Upper Reservoir). — This reservoir was completed late in the year 1905.

Hadley, Hart's Brook Reservoir. — This source was first used in 1905.

Holyoke, High Service Reservoir. — This reservoir was completed in 1904 and first used in 1906.

Lenox, Reservoir. — When this reservoir was drawn down in 1908 the dam was raised and the storage capacity greatly increased.

Lynn, Walden Reservoir. — The work of raising the dam at this reservoir was begun in 1902 and completed in 1906. By the raising of this dam the dam at Glen Lewis Reservoir was flooded to a depth of about 14 feet, so that these two reservoirs are one except at times when Walden Reservoir is drawn down lower than 14 feet.

Manchester, Gravel Pond. — This source was first used in 1909.

Milford, Charles River, filtered. — The water of the Charles River is filtered through an artificial sand filter, and is mingled with ground water obtained from wells near the river.

Northampton, Mountain Street Reservoir. — This reservoir, which receives water from West Brook was completed in 1902, emptied in 1903, and not filled again and used until 1905.

Peabody, Suntaug Lake. — This source was first used in the latter part of 1905, and intermittently since that time.

Pittsfield, Ashley Lake. — The water of Ashley Lake flows down Ashley Brook and is supplied thence to the city.

Southbridge, Hatchet Brook Reservoir No. 4. — This reservoir was completed in 1906, and since 1908 its water has been filtered through artificial sand filters.

West Springfield, Bear Hole Brook, filtered. — This source was first used in 1907.

First in importance in comparing the waters of the various sources are the conditions affecting their safety for drinking, and these depend chiefly upon their comparative freedom from danger of contamination by the wastes of human life and industry. Although many of the watersheds of streams, ponds and reservoirs in Massachusetts used as sources of water supply contain human habitations, there are some cases in which cities and towns have purchased and removed all of the buildings within the watersheds of their sources of supply, thus preventing further danger of pollution from these places. In some cases where the watershed of a source of supply contains a large population sewers have been constructed, by which all or a part of the sewage and foul drainage is removed and disposed of outside of the watershed.

Many of the sources of supply in the State are now protected by the enforcement of rules and regulations which have been established from time to time by the State Board of Health under the provisions of public statutes, but there are still cases in which adequate sanitary protection is not provided. The sources for the protection of the purity of the water of which rules and regulations have been established are the following: —

TABLE No. 3.

Metropolitan Water District,	Ashland Reservoir, Chestnut Hill Reservoir, Framingham Reservoir No. 2, Framingham Reservoir No. 3, Hopkinton Reservoir, Lake Cochituate, Sudbury Reservoir, Wachusett Reservoir.
Abington and Rockland,	Big Sandy Pond.
Amherst,	Amethyst Brook.
Andover,	Haggett's Pond.
Attleborough,	Orr's Pond.[1]
Brockton and Whitman,	Silver Lake.
Cambridge,	Stony Brook Reservoir.
Chicopee,	Morton Brook, Cooley Brook, Abbe Reservoir.
Danvers and Middleton,	Middleton Pond, Swan's Pond.
Easthampton,	Bassett Brook.
Fall River,	North Watuppa Lake.
Falmouth,	Long Pond.
Fitchburg,	Falulah Reservoir, Scott Reservoir, Smith Reservoir, Meetinghouse Pond and Wachusett Lake.
Greenfield,	Glen Brook Reservoir.
Haverhill,	Kenoza Lake, Millvale Reservoir.
Holyoke,	Fomer Reservoir (Manhan River).
Lincoln and Concord,	Sandy Pond.
Lynn,	Breed's Reservoir, Birch Reservoir, Hawkes Reservoir, Walden Reservoir.
Marlborough,	Lake Williams, Millham Brook Reservoir.
Maynard,	White Pond.
Montague,	Lake Pleasant.
Northampton,	Roberts Meadow Brook, West Brook, Mountain Street Reservoir.
Northborough,	Cold Harbor Brook.
Norwood,	Buckmaster Pond.
Peabody,	Reservoir, Brown's Pond, Spring Pond.
Pittsfield,	Ashley Lake, Ashley Brook, Sacket Brook, Hathaway Brook, Mill Brook, Onota Lake.
Plymouth,	Lout Pond, Little South Pond, Great South Pond, Boot Pond.
Randolph and Holbrook,	Great Pond.

[1] Not used directly as a source of water supply.

Rockport, ...	Cape Pond.
Salem and Beverly, . . .	Wenham Lake, Longham Reservoir.
Springfield and Ludlow, . .	Jabish Brook, Broad Brook, Axe Factory Brook, Ludlow Reservoir, Chapin Pond, Five Mile Pond, Higher Brook, lower basin of Van Horn Reservoir.
Taunton, ...	Elder's Pond, Assawompsett Pond.
Wakefield, ...	Crystal Lake.
Westfield, ...	Moose Meadow Brook, Tillotson Brook.
West Springfield, ...	Darby Brook, Bear Hole Brook.
Weymouth, ...	Great Pond.
Winchester, ...	North Reservoir, Middle Reservoir, South Reservoir.
Worcester, ...	Tatnuck Brook, Lynde Brook, Kettle Brook.

Albuminoid and Free Ammonia in Surface-water Supplies.

The quantity of organic matter present in surface waters is best indicated by the determination of the ammonia, especially the albuminoid ammonia. The total quantity of albuminoid ammonia in the various sources of water supply and the quantity of albuminoid ammonia in suspension are shown in the following table, in which the waters have been arranged in accordance with the average total quantity of albuminoid ammonia for the past five years. The averages of the maximum amounts in each of the five years are also presented. For convenience the quantity of free ammonia is also included in the table.

Table No. 4. — *Albuminoid Ammonia and Free Ammonia in Surface Waters arranged in Order of Albuminoid Ammonia.*

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Cheshire, ...	Kitchen Brook, ...	.0034	.0038	.0084	.0007	.0008
Great Barrington, . .	Green River, ...	.0034	.0046	.0062	.0005	.0013
Blandford, ...	Freeland Brook, ...	.0035	.0035	.0052	–	.0004
Adams, ...	Bassett Brook, ...	.0038	.0047	.0060	.0003	.0012
Deerfield, ...	Roaring Brook, ...	.0038	.0054	.0116	.0003	.0009
Cheshire, ...	Thunder Brook, ...	.0043	.0048	.0090	.0007	.0011
West Springfield, . .	Bear Hole Brook, filtered, .	.0043	.0078	.0090	–	.0009

TABLE No. 4. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia.				Free Ammonia. Average for 5 Years.
		Total.			Suspended. Average for 5 Years.	
		Average for 5 Years.	Average of Maximum for 5 Years.	Maximum during 5 Years.		
Chicopee,	Morton Brook,	.0044	.0059	.0110	.0009	.0011
Pittsfield,	Hathaway Brook,	.0048	.0063	.0094	.0006	.0007
Northampton,	West Brook,	.0054	.0100	.0116	.0008	.0008
Longmeadow,	Cooley Brook,	.0056	.0066	.0082	.0011	.0016
Chester,	Austin Brook,	.0057	.0058	.0092	.0004	.0010
Hatfield,	Running Gutter Brook Reservoir.	.0057	.0103	.0228	.0010	.0012
Huntington,	Cold Brook,	.0059	.0088	.0142	.0006	.0007
Pittsfield,	Mill Brook,	.0069	.0103	.0166	.0008	.0009
Milford,	Charles River, filtered,	.0071	.0094	.0110	–	.0010
Stoughton,	Muddy Pond Brook,	.0072	.0100	.0132	–	.0007
North Adams,	Broad Brook,	.0074	.0122	.0146	.0009	.0026
Greenfield,	Glen Brook, lower reservoir,	.0077	.0128	.0164	.0016	.0025
North Adams,	Notch Brook Reservoir,	.0078	.0149	.0286	.0020	.0034
Pittsfield,	Sacket Brook,	.0080	.0095	.0168	.0016	.0018
Williamsburg,	Reservoir,	.0080	.0131	.0212	.0011	.0027
Greenfield,	Glen Brook, upper reservoir,	.0081	.0117	.0154	.0019	.0023
Adams,	Dry Brook,	.0083	.0101	.0120	.0011	.0014
Wareham,	Jonathan Pond,	.0083	.0107	.0124	.0012	.0011
Westfield,	Tillotson Brook Reservoir,	.0083	.0132	.0180	.0015	.0021
Montague,	Lake Pleasant,	.0084	.0110	.0132	.0016	.0024
Great Barrington,	East Mountain Reservoir,	.0086	.0122	.0168	.0020	.0040
Hadley,	Hart's Brook Reservoir,	.0088	.0240	.0328	.0024	.0022
Northampton,	Mountain Street Reservoir,	.0088	.0133	.0216	.0019	.0012
Falmouth,	Long Pond,	.0096	.0115	.0126	.0013	.0009
Ashfield,	Bear Swamp Brook,	.0097	.0163	.0304	.0010	.0015
Lawrence,	Merrimack River, filtered,	.0097	.0120	.0135	–	.0047
Holyoke,	Fomer Reservoir,	.0099	.0145	.0170	.0014	.0016
Lee,	Codding Brook, lower reservoir.	.0104	.0144	.0178	.0012	.0026
Easthampton,	Bassett Brook,	.0105	.0131	.0176	.0018	.0014
Amherst,	Amethyst Brook Reservoir,	.0109	.0157	.0188	.0027	.0016
Holden,	Muschopauge Lake,	.0112	.0132	.0156	.0016	.0019
Maynard,	White Pond,	.0112	.0135	.0180	.0013	.0011

TABLE No. 4. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Dalton,	Egypt Brook Reservoir,	.0113	.0188	.0224	.0020	.0024
Hudson,	Fosgate Brook,	.0115	.0153	.0170	.0011	.0040
Lenox,	Reservoir,	.0117	.0162	.0194	.0023	.0018
South Hadley,	Buttery Brook Reservoir,	.0117	.0202	.0352	.0036	.0066
Chicopee,	Cooley Brook,	.0118	.0156	.0300	.0036	.0012
Fitchburg,	Meetinghouse Pond,	.0118	.0153	.0166	.0019	.0030
Metropolitan Water District.	Tap in Quincy,	.0119	.0150	.0166	.0012	.0014
Hingham,	Accord Pond,	.0122	.0169	.0266	.0017	.0014
Worcester,	Lower Holden Reservoir,	.0122	.0160	.0190	.0022	.0019
Brockton,	Silver Lake,	.0125	.0179	.0240	.0023	.0015
Pittsfield,	Ashley Brook,	.0125	.0158	.0182	.0017	.0028
Worcester,	Upper Holden Reservoir,	.0125	.0162	.0190	.0025	.0020
Lee,	Basin Pond Brook,	.0126	.0205	.0316	.0024	.0031
Metropolitan Water District.	Tap in Revere,	.0127	.0148	.0168	.0016	.0014
Northampton,	Middle Reservoir,	.0127	.0216	.0308	.0024	.0020
Peabody,	Spring Pond,	.0127	.0168	.0208	.0027	.0081
Metropolitan Water District.	Weston Reservoir,	.0128	.0162	.0180	.0021	.0020
Concord,	Sandy Pond,	.0130	.0188	.0224	.0035	.0013
Plymouth,	Great South Pond,	.0130	.0187	.0260	.0020	.0014
Metropolitan Water District.	Wachusett Reservoir,	.0136	.0220	.0280	.0025	.0022
Metropolitan Water District.	Tap in State House,	.0136	.0189	.0224	.0023	.0015
Worcester,	Leicester Reservoir,	.0138	.0169	.0186	.0019	.0038
Metropolitan Water District.	Sudbury Reservoir,	.0140	.0187	.0218	.0024	.0032
Fitchburg,	Wachusett Lake,	.0142	.0189	.0224	.0031	.0025
Metropolitan Water District.	Chestnut Hill Reservoir,	.0146	.0178	.0188	.0028	.0024
Metropolitan Water District.	Framingham Reservoir No. 3.	.0148	.0196	.0242	.0031	.0026
Metropolitan Water District.	Spot Pond,	.0148	.0185	.0206	.0023	.0019
Plymouth,	Little South Pond,	.0148	.0202	.0222	.0026	.0013
Worcester,	Mann Reservoir,	.0148	.0214	.0276	.0032	.0017
Andover,	Haggett's Pond,	.0149	.0171	.0186	.0013	.0013
Springfield,	Ludlow Canal,	.0149	.0272	.0324	.0020	.0020
Westfield,	Tekoa Reservoir,	.0149	.0230	.0270	.0024	.0024

TABLE No. 4. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Manchester,	Gravel Pond,	.0151	.0231	.0290	.0019	.0015
Spencer,	Shaw Pond,	.0151	.0227	.0496	.0013	.0025
West Springfield,	Darby Brook Reservoir,	.0151	.0208	.0310	.0061	.0066
Hudson,	Gates Pond,	.0153	.0185	.0202	.0028	.0028
Leominster,	Fall Brook Reservoir,	.0154	.0202	.0234	.0033	.0017
Palmer,	Lower reservoir,	.0154	.0222	.0300	.0038	.0025
Springfield,	Ludlow Basin,	.0155	.0197	.0222	.0032	.0015
Worcester,	Kent Reservoir,	.0155	.0200	.0216	.0030	.0017
Abington,	Big Sandy Pond,	.0156	.0186	.0210	.0020	.0025
Gloucester,	Haskell Brook Reservoir,	.0157	.0190	.0208	.0025	.0095
Haverhill,	Lake Saltonstall,	.0157	.0208	.0294	.0023	.0020
Taunton,	Elder's Pond,	.0157	.0191	.0198	.0021	.0015
Haverhill,	Kenoza Lake,	.0160	.0200	.0212	.0023	.0022
Haverhill,	Crystal Lake,	.0161	.0192	.0214	.0018	.0019
Norwood,	Buckmaster Pond,	.0162	.0213	.0238	.0039	.0110
Haverhill,	Pentucket Lake,	.0163	.0205	.0242	.0027	.0016
Peabody,	Brown's Pond,	.0163	.0251	.0388	.0030	.0020
Northbridge,	Cook Allen Reservoir,	.0165	.0252	.0408	.0033	.0031
Gardner,	Crystal Lake,	.0167	.0224	.0282	.0022	.0024
Peabody,	Suntaug Lake,	.0167	.0236	.0300	.0029	.0030
Pittsfield,	Ashley Lake,	.0168	.0211	.0240	.0020	.0031
Haverhill,	Johnson's Pond,	.0169	.0197	.0200	.0019	.0018
Nantucket,	Wannacomet Pond,	.0169	.0258	.0440	.0055	.0026
Ipswich,	Dow's Brook Reservoir,	.0170	.0221	.0270	.0026	.0023
Gloucester,	Dike's Brook Reservoir,	.0172	.0208	.0256	.0031	.0029
Weymouth,	Great Pond,	.0174	.0211	.0264	.0020	.0032
Taunton,	Assawompsett Pond,	.0175	.0200	.0210	.0025	.0022
Winchester,	South Reservoir,	.0175	.0214	.0270	.0025	.0068
North Andover,	Great Pond,	.0176	.0213	.0230	.0022	.0023
Fall River,	North Watuppa Lake,	.0177	.0202	.0214	.0028	.0019
Metropolitan Water District.	Hopkinton Reservoir,	.0178	.0220	.0242	.0022	.0029
Randolph,	Great Pond,	.0178	.0219	.0306	.0020	.0018

TABLE No. 4. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Fitchburg,	Scott Reservoir,	.0179	.0279	.0464	.0049	.0049
New Bedford,	Little Quittacas Pond,	.0179	.0218	.0260	.0025	.0025
Springfield,	Five Mile Pond,	.0182	.0240	.0256	.0028	.0042
Springfield,	Loon Pond,	.0185	.0246	.0378	.0032	.0020
Danvers,	Middleton Pond,	.0186	.0213	.0244	.0023	.0018
Winchester,	North Reservoir,	.0186	.0237	.0278	.0034	.0041
Marlborough,	Lake Williams,	.0187	.0219	.0268	.0028	.0028
Leominster,	Morse Reservoir,	.0189	.0288	.0356	.0038	.0032
Springfield,	Chapin Pond,	.0189	.0230	.0312	.0044	.0025
Worcester,	Bottomly Reservoir,	.0190	.0238	.0336	.0030	.0031
Wakefield,	Crystal Lake,	.0191	.0257	.0312	.0038	.0041
New Bedford,	Great Quittacas Pond,	.0192	.0242	.0312	.0021	.0024
Metropolitan Water District.	Ashland Reservoir,	.0197	.0241	.0264	.0024	.0024
Barre,	Reservoir,	.0197	.0278	.0324	.0042	.0028
Holyoke,	Wright and Ashley Pond,	.0198	.0318	.0350	.0035	.0044
Gloucester,	Wallace Reservoir,	.0201	.0255	.0332	.0046	.0024
Lee,	Codding Brook, upper reservoir.	.0203	.0337	.0476	.0040	.0042
Stockbridge,	Lake Averic,	.0206	.0284	.0374	.0049	.0036
Westfield,	Montgomery Reservoir,	.0210	.0320	.0362	.0049	.0041
Metropolitan Water District.	Framingham Reservoir No. 2.	.0212	.0308	.0348	.0024	.0031
Cambridge,	Stony Brook Reservoir,	.0213	.0258	.0282	.0027	.0030
Lynn,	Breed's Reservoir,	.0213	.0294	.0376	.0035	.0045
Haverhill,	Millvale Reservoir,	.0217	.0272	.0310	.0038	.0030
Springfield,	Ludlow Reservoir,	.0217	.0487	.0950	.0072	.0030
Salem,	Wenham Lake,	.0218	.0347	.0560	.0051	.0064
Southbridge,	Hatchet Brook Reservoir No. 3.	.0218	.0344	.0424	.0054	.0037
Metropolitan Water District.	Lake Cochituate,	.0221	.0353	.0464	.0049	.0029
Holyoke,	High Service Reservoir,	.0222	.0331	.0408	.0043	.0028
South Hadley,	Leaping Well Reservoir,	.0222	.0376	.0536	.0092	.0063
Marlborough,	Millham Brook Reservoir,	.0224	.0290	.0338	.0046	.0043
Lynn,	Birch Reservoir,	.0230	.0303	.0340	.0047	.0058
Holyoke,	Whiting Street Reservoir,	.0231	.0381	.0728	.0068	.0040

TABLE No. 4. — *Albuminoid Ammonia and Free Ammonia in Surface Waters, etc.* — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia.				Free Ammonia. Average for 5 Years.
		Total.			Suspended. Average for 5 Years.	
		Average for 5 Years.	Average of Maximum for 5 Years.	Maximum during 5 Years.		
Athol,	Buckman Brook Reservoir,	.0232	.0408	.0566	.0076	.0033
Northborough,	Lower reservoir,	.0232	.0338	.0536	.0046	.0043
North Brookfield,	Doane Pond,	.0233	.0303	.0344	.0049	.0050
Lynn,	Walden Reservoir,	.0235	.0288	.0372	.0040	.0071
Wayland,	Snake Brook Reservoir,	.0239	.0329	.0432	.0039	.0056
Brockton,	Salisbury Brook Reservoir,	.0242	.0328	.0380	.0051	.0026
Cambridge,	Lower Hobbs Brook Reservoir.	.0247	.0304	.0328	.0042	.0032
Lynn,	Hawkes Reservoir,	.0258	.0382	.0528	.0033	.0049
Southbridge,	Hatchet Brook Reservoir No. 4.	.0276	.0525	.0630	.0081	.0094
Winchester,	Middle Reservoir,	.0278	.0391	.0468	.0063	.0070
Cambridge,	Fresh Pond,	.0281	.0454	.0498	.0097	.0087
Leominster,	Haynes Reservoir,	.0310	.0432	.0562	.0088	.0076
North Brookfield,	North Pond,	.0312	.0428	.0576	.0098	.0060
Rockport,	Cape Pond,	.0326	.0575	.0904	.0122	.0074
Cambridge,	Upper Hobbs Brook Reservoir.	.0327	.0404	.0494	.0072	.0041
Lynn,	Saugus River,	.0335	.0531	.0684	.0034	.0057
Salem,	Longham Reservoir,	.0345	.0651	.0755	.0082	.0103
Athol,	Phillipston Reservoir,	.0408	.0790	.0908	.0158	.0096

In the foregoing table, of the first 34 waters in which the average albuminoid ammonia has been less than .0100 of a part in 100,000, 21 are streams, 3 are natural ponds, — viz., Lake Pleasant in Montague, Jonathan Pond in Wareham and Long Pond in Falmouth, — and 10 are artificial storage reservoirs. Of the artificial storage reservoirs, the Fomer Reservoir of the city of Holyoke, the Tillotson Brook Reservoir of the town of Westfield and the reservoirs of the towns of Hadley, Hatfield, Williamsburg and Great Barrington are very small. On the other hand, among the 21 waters at the foot of the list having an average of more than .0225 of a part in 100,000 of albuminoid ammonia, there are no streams and only 2 natural ponds, — Cape Pond in Rockport and Fresh Pond in Cambridge, the latter being supplied chiefly with water from the Stony Brook watershed. With these two exceptions all are stor-

age reservoirs, nearly all of which were formed by the flooding of areas from which the soil and organic matters were not removed. For convenience in comparison this table has been subdivided into three classes, streams, lakes and ponds, and artificial storage reservoirs.

TABLE No. 5. — *Albuminoid Ammonia and Free Ammonia in the Water of Streams, arranged in Order of Albuminoid Ammonia.*

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Cheshire,	Kitchen Brook,	.0034	.0038	.0084	.0007	.0008
Great Barrington,	Green River,	.0034	.0046	.0062	.0005	.0013
Blandford,	Freeland Brook,	.0035	.0035	.0052	–	.0004
Adams,	Bassett Brook,	.0038	.0047	.0060	.0003	.0012
Deerfield,	Roaring Brook,	.0038	.0054	.0116	.0003	.0009
Cheshire,	Thunder Brook,	.0043	.0048	.0090	.0007	.0011
West Springfield,	Bear Hole Brook, filtered,	.0043	.0078	.0090	–	.0009
Chicopee,	Morton Brook,	.0044	.0059	.0110	.0009	.0011
Pittsfield,	Hathaway Brook,	.0048	.0063	.0094	.0006	.0007
Northampton,	West Brook,	.0054	.0100	.0116	.0008	.0008
Longmeadow,	Cooley Brook,	.0056	.0066	.0082	.0011	.0016
Chester,	Austin Brook,	.0057	.0058	.0092	.0004	.0010
Huntington,	Cold Brook,	.0059	.0088	.0142	.0006	.0007
Pittsfield,	Mill Brook,	.0069	.0103	.0166	.0008	.0009
Milford,	Charles River, filtered,	.0071	.0094	.0110	–	.0010
Stoughton,	Muddy Pond Brook,	.0072	.0100	.0132	–	.0007
North Adams,	Broad Brook,	.0074	.0122	.0146	.0009	.0026
Pittsfield,	Sacket Brook,	.0080	.0095	.0168	.0016	.0018
Adams,	Dry Brook,	.0083	.0101	.0120	.0011	.0014
Ashfield,	Bear Swamp Brook,	.0097	.0163	.0304	.0010	.0015
Lawrence,	Merrimack River, filtered,	.0097	.0120	.0135	–	.0047
Easthampton,	Bassett Brook,	.0105	.0131	.0176	.0018	.0014
Hudson,	Fosgate Brook,	.0115	.0153	.0170	.0011	.0040
Chicopee,	Cooley Brook,	.0118	.0156	.0300	.0036	.0012
Pittsfield,	Ashley Brook,	.0125	.0158	.0182	.0017	.0028
Lee,	Basin Pond Brook,	.0126	.0205	.0316	.0024	.0031
Springfield,	Ludlow Canal,	.0149	.0272	.0324	.0020	.0020
Lynn,	Saugus River,	.0335	.0531	.0684	.0034	.0057

TABLE No. 6. — *Albuminoid Ammonia and Free Ammonia in the Water of Lakes and Ponds, arranged in Order of Albuminoid Ammonia.*

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Wareham,	Jonathan Pond,	.0083	.0107	.0124	.0012	.0011
Montague,	Lake Pleasant,	.0084	.0110	.0132	.0016	.0024
Falmouth,	Long Pond,	.0096	.0115	.0126	.0013	.0009
Holden,	Muschopauge Lake,	.0112	.0132	.0156	.0016	.0019
Maynard,	White Pond,	.0112	.0135	.0180	.0013	.0011
Fitchburg,	Meetinghouse Pond,	.0118	.0153	.0166	.0019	.0030
Hingham,	Accord Pond,	.0122	.0169	.0266	.0017	.0014
Brockton,	Silver Lake,	.0125	.0179	.0240	.0023	.0015
Peabody,	Spring Pond,	.0127	.0168	.0208	.0027	.0081
Concord,	Sandy Pond,	.0130	.0188	.0224	.0035	.0013
Plymouth,	Great South Pond,	.0130	.0187	.0260	.0020	.0014
Fitchburg,	Wachusett Lake,	.0142	.0189	.0224	.0031	.0025
Plymouth,	Little South Pond,	.0148	.0202	.0222	.0026	.0013
Andover,	Haggett's Pond,	.0149	.0171	.0186	.0013	.0013
Manchester,	Gravel Pond,	.0151	.0231	.0290	.0019	.0015
Spencer,	Shaw Pond,	.0151	.0227	.0496	.0013	.0025
Hudson,	Gates Pond,	.0153	.0185	.0202	.0028	.0028
Abington,	Big Sandy Pond,	.0156	.0186	.0210	.0020	.0025
Haverhill,	Lake Saltonstall,	.0157	.0208	.0294	.0023	.0020
Taunton,	Elder's Pond,	.0157	.0191	.0198	.0021	.0015
Haverhill,	Kenoza Lake,	.0160	.0200	.0212	.0023	.0022
Haverhill,	Crystal Lake,	.0161	.0192	.0214	.0018	.0019
Norwood,	Buckmaster Pond,	.0162	.0213	.0238	.0039	.0110
Haverhill,	Pentucket Lake,	.0163	.0205	.0242	.0027	.0016
Peabody,	Brown's Pond,	.0163	.0251	.0388	.0030	.0020
Gardner,	Crystal Lake,	.0167	.0224	.0282	.0022	.0024
Peabody,	Suntaug Lake,	.0167	.0236	.0300	.0029	.0030
Pittsfield,	Ashley Lake,	.0168	.0211	.0240	.0020	.0031
Haverhill,	Johnson's Pond,	.0169	.0197	.0200	.0019	.0018
Nantucket,	Wannacomet Pond,	.0169	.0258	.0440	.0055	.0026
Weymouth,	Great Pond,	.0174	.0211	.0264	.0020	.0032
Taunton,	Assawompsett Pond,	.0175	.0200	.0210	.0025	.0022
North Andover,	Great Pond,	.0176	.0213	.0230	.0022	.0023

TABLE No. 6. — *Albuminoid Ammonia and Free Ammonia in the Water of Lakes and Ponds, etc.* — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Fall River,	North Watuppa Lake,	.0177	.0202	.0214	.0028	.0019
Randolph,	Great Pond,	.0178	.0219	.0306	.0020	.0018
New Bedford,	Little Quittacas Pond,	.0179	.0218	.0260	.0025	.0025
Springfield,	Five Mile Pond,	.0182	.0240	.0256	.0028	.0042
Springfield,	Loon Pond,	.0185	.0246	.0378	.0032	.0020
Danvers,	Middleton Pond,	.0186	.0213	.0244	.0023	.0018
Marlborough,	Lake Williams,	.0187	.0219	.0268	.0028	.0028
Springfield,	Chapin Pond,	.0189	.0230	.0312	.0044	.0025
Wakefield,	Crystal Lake,	.0191	.0257	.0312	.0038	.0041
New Bedford,	Great Quittacas Pond,	.0192	.0242	.0312	.0021	.0024
Stockbridge,	Lake Averic,	.0206	.0284	.0374	.0049	.0036
Salem,	Wenham Lake,	.0218	.0347	.0560	.0051	.0064
Metropolitan Water District.	Lake Cochituate,	.0221	.0353	.0464	.0049	.0029
Cambridge,	Fresh Pond,	.0281	.0454	.0498	.0097	.0087
Rockport,	Cape Pond,	.0326	.0575	.0904	.0122	.0074

TABLE No. 7. — *Albuminoid Ammonia and Free Ammonia in the Water of Storage Reservoirs, arranged in Order of Albuminoid Ammonia.*

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Hatfield,	Running Gutter Brook Reservoir.	.0057	.0103	.0228	.0010	.0012
Greenfield,	Glen Brook lower reservoir.	.0077	.0128	.0164	.0016	.0025
North Adams,	Notch Brook Reservoir,	.0078	0149	.0286	.0020	.0034
Williamsburg,	Reservoir,	.0080	.0131	.0212	.0011	.0027
Greenfield,	Glen Brook upper reservoir,	.0081	.0117	.0154	.0019	.0023
Westfield,	Tillotson Brook Reservoir,	.0083	.0132	.0180	.0015	.0021
Great Barrington,	East Mountain Reservoir,	.0086	.0122	.0168	.0020	.0040

TABLE NO. 7. — *Albuminoid Ammonia and Free Ammonia in the Water of Storage Reservoirs, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Hadley,	Hart's Brook Reservoir,	.0088	.0240	.0328	.0024	.0022
Northampton,	Mountain Street Reservoir,	.0088	.0133	.0216	.0019	.0012
Holyoke,	Fomer Reservoir,	.0099	.0145	.0170	.0014	.0016
Lee,	Codding Brook lower reservoir.	.0104	.0144	.0178	.0012	.0026
Amherst,	Amethyst Brook Reservoir,	.0109	.0157	.0188	.0027	.0016
Dalton,	Egypt Brook Reservoir,	.0113	.0188	.0224	.0020	.0024
Lenox,	Reservoir,	.0117	.0162	.0194	.0023	.0018
South Hadley,	Buttery Brook Reservoir,	.0117	.0202	.0352	.0036	.0066
Worcester,	Lower Holden Reservoir,	.0122	.0160	.0190	.0022	.0019
Worcester,	Upper Holden Reservoir,	.0125	.0162	.0190	.0025	.0020
Northampton,	Middle Reservoir,	.0127	.0216	.0308	.0024	.0020
Metropolitan Water District.	Wachusett Reservoir,	.0136	.0220	.0280	.0025	.0022
Worcester,	Leicester Reservoir,	.0138	.0169	.0186	.0019	.0038
Metropolitan Water District.	Sudbury Reservoir,	.0140	.0187	.0218	.0024	.0032
Metropolitan Water District.	Framingham Reservoir No. 3,	.0148	.0196	.0242	.0031	.0026
Worcester,	Mann Reservoir,	.0148	.0214	.0276	.0032	.0017
Westfield,	Tekoa Reservoir,	.0149	.0230	.0270	.0024	.0024
West Springfield,	Darby Brook Reservoir,	.0151	.0208	.0310	.0061	.0066
Leominster,	Fall Brook Reservoir,	.0154	.0202	.0234	.0033	.0017
Palmer,	Lower reservoir,	.0154	.0222	.0300	.0038	.0025
Worcester,	Kent Reservoir,	.0155	.0200	.0216	.0030	.0017
Gloucester,	Haskell Brook Reservoir,	.0157	.0190	.0208	.0025	.0095
Northbridge,	Cook Allen Reservoir,	.0165	.0252	.0408	.0033	.0031
Ipswich,	Dow's Brook Reservoir,	.0170	.0221	.0270	.0026	.0023
Gloucester,	Dike's Brook Reservoir,	.0172	.0208	.0256	.0031	.0029
Winchester,	South Reservoir,	.0175	.0214	.0270	.0025	.0068
Metropolitan Water District.	Hopkinton Reservoir,	.0178	.0220	.0242	.0022	.0029
Fitchburg,	Scott Reservoir,	.0179	.0279	.0464	.0049	.0049
Winchester,	North Reservoir,	.0186	.0237	.0278	.0034	.0041
Leominster,	Morse Reservoir,	.0189	.0288	.0356	.0038	.0032
Worcester,	Bottomly Reservoir,	.0190	.0238	.0336	.0030	.0031
Metropolitan Water District.	Ashland Reservoir,	.0197	.0241	.0264	.0024	.0024

TABLE NO. 7. — *Albuminoid Ammonia and Free Ammonia in the Water of Storage Reservoirs, etc.* — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Albuminoid Ammonia. Total. Average for 5 Years.	Albuminoid Ammonia. Total. Average of Maximum for 5 Years.	Albuminoid Ammonia. Total. Maximum during 5 Years.	Albuminoid Ammonia. Suspended. Average for 5 Years.	Free Ammonia. Average for 5 Years.
Barre,	Reservoir,	.0197	.0278	.0324	.0042	.0028
Holyoke,	Wright and Ashley Pond,	.0198	.0318	.0350	.0035	.0044
Gloucester,	Wallace Reservoir,	.0201	.0255	.0332	.0046	.0024
Lee,	Codding Brook upper reservoir.	.0203	.0337	.0476	.0040	.0042
Westfield,	Montgomery Reservoir,	.0210	.0320	.0362	.0049	.0041
Metropolitan Water District.	Framingham Reservoir No. 2,	.0212	.0308	.0348	.0024	.0031
Cambridge,	Stony Brook Reservoir,	.0213	.0258	.0282	.0027	.0030
Lynn,	Breed's Reservoir,	.0213	.0294	.0376	.0035	.0045
Haverhill,	Millvale Reservoir,	.0217	.0272	.0310	.0038	.0030
Springfield,	Ludlow Reservoir,	.0217	.0487	.0950	.0072	.0030
Southbridge,	Hatchet Brook Reservoir No. 3.	.0218	.0344	.0424	.0054	.0037
Holyoke,	High Service Reservoir,	.0222	.0331	.0408	.0043	.0028
South Hadley,	Leaping Well Reservoir,	.0222	.0376	.0536	.0092	.0063
Marlborough,	Millham Brook Reservoir,	.0224	.0290	.0338	.0046	.0043
Lynn,	Birch Reservoir,	.0230	.0303	.0340	.0047	.0058
Holyoke,	Whiting Street Reservoir,	.0231	.0381	.0728	.0068	.0040
Athol,	Buckman Brook Reservoir,	.0232	.0408	.0566	.0076	.0033
Northborough,	Lower reservoir,	.0232	.0338	.0536	.0046	.0043
North Brookfield,	Doane Pond,	.0233	.0303	.0344	.0049	.0050
Lynn,	Walden Reservoir,	.0235	.0288	.0372	.0040	.0071
Wayland,	Snake Brook Reservoir,	.0239	.0329	.0432	.0039	.0056
Brockton,	Salisbury Brook Reservoir,	.0242	.0328	.0380	.0051	.0026
Cambridge,	Lower Hobbs Brook Reservoir.	.0247	.0304	.0328	.0042	.0032
Lynn,	Hawkes Reservoir,	.0258	.0382	.0528	.0033	.0049
Southbridge,	Hatchet Brook Reservoir No. 4.	.0276	.0525	.0630	.0081	.0094
Winchester,	Middle Reservoir,	.0278	.0391	.0468	.0063	.0070
Leominster,	Haynes Reservoir,	.0310	.0432	.0562	.0088	.0076
North Brookfield,	North Pond,	.0312	.0428	.0576	.0098	.0060
Cambridge,	Upper Hobbs Brook Reservoir.	.0327	.0404	.0494	.0072	.0041
Salem,	Longham Reservoir,	.0345	.0651	.0755	.0082	.0103
Athol,	Phillipston Reservoir,	.0408	.0790	.0908	.0158	.0096

Free Ammonia in Surface Waters.

The quantity of free ammonia present in the various surface-water supplies of the State is for the most part small, and its presence is due to various causes. It is a characteristic ingredient of sewage, and in sewage-polluted waters it is present in large quantities, but free ammonia is a product of decay, and there are many conditions which cause its development or disappearance in surface waters. Some of the deeper lakes and ponds show a decided increase in free ammonia in the late fall or early winter, due to the accumulation of ammonia during the warm weather in the lower stagnant layers, which is distributed throughout the water as the coming of cold weather puts these deeper layers into circulation. In ponds and reservoirs in which there are excessive growths of organisms, such for example as Cape Pond at Rockport, Hatchet Brook Reservoir at Southbridge, Phillipston Reservoir at Athol and Longham Reservoir at Salem, free ammonia is present frequently in large quantities. The quantity of free ammonia present in the various surface-water supplies is given in Table No. 8, and the quantity in streams, ponds and storage reservoirs separately is given in tables Nos. 9, 10 and 11.

Table No. 8. — *Free Ammonia in Surface Waters.*

[Parts in 100,000.]

Blandford, Freeland Brook,	.0004	Andover, Haggett's Pond,	.0013
Huntington, Cold Brook,	.0007	Concord, Sandy Pond,	.0013
Pittsfield, Hathaway Brook,	.0007	Great Barrington, Green River,	.0013
Stoughton, Muddy Pond Brook,	.0007	Plymouth, Little South Pond,	.0013
Cheshire, Kitchen Brook,	.0008	Metropolitan Water District, tap in Revere,	.0014
Northampton, West Brook,	.0008	Metropolitan Water District, tap in Quincy,	.0014
Deerfield, Roaring Brook,	.0009	Adams, Dry Brook,	.0014
Falmouth, Long Pond,	.0009	Easthampton, Bassett Brook,	.0014
Pittsfield, Mill Brook,	.0009	Hingham, Accord Pond,	.0014
West Springfield, Bear Hole Brook, filtered,	.0009	Plymouth, Great South Pond,	.0014
Chester, Austin Brook,	.0010	Metropolitan Water District, tap in State House.	.0015
Milford, Charles River, filtered,	.0010	Ashfield, Bear Swamp Brook,	.0015
Cheshire, Thunder Brook,	.0011	Brockton, Silver Lake,	.0015
Chicopee, Morton Brook,	.0011	Manchester, Gravel Pond,	.0015
Maynard, White Pond,	.0011	Springfield, Ludlow Basin,	.0015
Wareham, Jonathan Pond,	.0011	Taunton, Elder's Pond,	.0015
Adams, Bassett Brook,	.0012	Amherst, Amethyst Brook Reservoir,	.0016
Chicopee, Cooley Brook,	.0012	Haverhill, Pentucket Lake,	.0016
Hatfield, Running Gutter Brook Reservoir,	.0012	Holyoke, Fomer Reservoir,	.0016
Northampton, Mountain Street Reservoir,	.0012	Longmeadow, Cooley Brook,	.0016

TABLE No. 8. — *Free Ammonia in Surface Waters* — Continued.

[Parts in 100,000.]

Leominster, Fall Brook Reservoir,	.0017
Worcester, Kent Reservoir,	.0017
Worcester, Mann Reservoir,	.0017
Danvers, Middleton Pond,	.0018
Haverhill, Johnson's Pond,	.0018
Lenox, reservoir,	.0018
Pittsfield, Sacket Brook,	.0018
Randolph, Great Pond,	.0018
Metropolitan Water District, Spot Pond,	.0019
Fall River, North Watuppa Lake,	.0019
Haverhill, Crystal Lake,	.0019
Holden, Muschopauge Lake,	.0019
Worcester, Lower Holden Reservoir,	.0019
Metropolitan Water District, Weston Reservoir.	.0020
Haverhill, Lake Saltonstall,	.0020
Northampton, Middle Reservoir,	.0020
Peabody, Brown's Pond,	.0020
Springfield, Ludlow Canal,	.0020
Springfield, Loon Pond,	.0020
Worcester, Upper Holden Reservoir,	.0020
Westfield, Tillotson Brook Reservoir,	.0021
Metropolitan Water District, Wachusett Reservoir.	.0022
Hadley, Hart's Brook Reservoir,	.0022
Haverhill, Kenoza Lake,	.0022
Taunton, Assawompsett Pond,	.0022
Greenfield, Glen Brook upper reservoir,	.0023
Ipswich, Dow's Brook Reservoir,	.0023
North Andover, Great Pond,	.0023
Metropolitan Water District, Ashland Reservoir.	.0024
Metropolitan Water District, Chestnut Hill Reservoir.	.0024
Dalton, Egypt Brook Reservoir,	.0024
Gardner, Crystal Lake,	.0024
Gloucester, Wallace Reservoir,	.0024
Montague, Lake Pleasant,	.0024
New Bedford, Great Quittacas Pond,	.0024
Westfield, Tekoa Reservoir,	.0024
Abington, Big Sandy Pond,	.0025
Fitchburg, Wachusett Lake,	.0025
Greenfield, Glen Brook lower reservoir,	.0025
New Bedford, Little Quittacas Pond,	.0025
Palmer, lower reservoir,	.0025
Spencer, Shaw Pond,	.0025
Springfield, Chapin Pond,	.0025
Metropolitan Water District, Framingham Reservoir No. 3.	.0026
Brockton, Salisbury Brook Reservoir,	.0026
Lee, Codding Brook lower reservoir,	.0026
Nantucket, Wannacomet Pond,	.0026
North Adams, Broad Brook,	.0026
Williamsburg, reservoir,	.0027
Barre, reservoir,	.0028
Holyoke, High Service Reservoir,	.0028
Hudson, Gates Pond,	.0028
Marlborough, Lake Williams,	.0028
Pittsfield, Ashley Brook,	.0028
Metropolitan Water District, Hopkinton Reservoir.	.0029
Metropolitan Water District, Lake Cochituate.	.0029
Gloucester, Dike's Brook Reservoir,	.0029
Cambridge, Stony Brook Reservoir,	.0030
Fitchburg, Meetinghouse Pond,	.0030
Haverhill, Millvale Reservoir,	.0030
Peabody, Suntaug Lake,	.0030
Springfield, Ludlow Reservoir,	.0030
Metropolitan Water District, Framingham Reservoir No. 2.	.0031
Lee, Basin Pond Brook,	.0031
Northbridge, Cook Allen Reservoir,	.0031
Pittsfield, Ashley Lake,	.0031
Worcester, Bottomly Reservoir,	.0031
Metropolitan Water District, Sudbury Reservoir.	.0032
Cambridge, Lower Hobbs Brook Reservoir,	.0032
Leominster, Morse Reservoir,	.0032
Weymouth, Great Pond,	.0032
Athol, Buckman Brook Reservoir,	.0033
North Adams, Notch Brook Reservoir,	.0034
Stockbridge, Lake Averic,	.0036
Southbridge, Hatchet Brook Reservoir No. 3.	.0037
Worcester, Leicester Reservoir,	.0038
Great Barrington, East Mountain Reservoir.	.0040
Holyoke, Whiting Street Reservoir,	.0040
Hudson, Fosgate Brook,	.0040
Cambridge, Upper Hobbs Brook Reservoir,	.0041

TABLE No. 8. — *Free Ammonia in Surface Waters* — Concluded.

[Parts in 100,000.]

Wakefield, Crystal Lake,	.0041	South Hadley, Leaping Well Reservoir,	.0063
Westfield, Montgomery Reservoir,	.0041	Salem, Wenham Lake,	.0064
Winchester, North Reservoir,	.0041	South Hadley, Buttery Brook Reservoir,	.0066
Lee, Codding Brook upper reservoir,	.0042	West Springfield, Darby Brook Reservoir,	.0066
Springfield, Five Mile Pond,	.0042	Winchester, South Reservoir,	.0068
Marlborough, Millham Brook Reservoir,	.0043	Winchester, Middle Reservoir,	.0070
Northborough, lower reservoir,	.0043	Lynn, Walden Reservoir,	.0071
Holyoke, Wright and Ashley Pond,	.0044	Rockport, Cape Pond,	.0074
Lynn, Breed's Reservoir,	.0045	Leominster, Haynes Reservoir,	.0076
Lawrence, Merrimack River, filtered,	.0047	Peabody, Spring Pond,	.0081
Fitchburg, Scott Reservoir,	.0049	Cambridge, Fresh Pond,	.0087
Lynn, Hawkes Reservoir,	.0049	Southbridge, Hatchet Brook Reservoir No. 4.	.0094
North Brookfield, Doane Pond,	.0050	Gloucester, Haskell Brook Reservoir,	.0095
Wayland, Snake Brook Reservoir,	.0056	Athol, Phillipston Reservoir,	.0096
Lynn, Saugus River,	.0057	Salem, Longham Reservoir,	.0103
Lynn, Birch Reservoir,	.0058	Norwood, Buckmaster Pond,	.0110
North Brookfield, North Pond,	.0060		

TABLE No. 9. — *Free Ammonia in the Water of Streams.*

[Parts in 100,000.]

Blandford, Freeland Brook,	.0004	Chicopee, Cooley Brook,	.0012
Huntington, Cold Brook,	.0007	Great Barrington, Green River,	.0013
Pittsfield, Hathaway Brook,	.0007	Adams, Dry Brook,	.0014
Stoughton, Muddy Pond Brook,	.0007	Easthampton, Bassett Brook,	.0014
Cheshire, Kitchen Brook,	.0008	Ashfield, Bear Swamp Brook,	.0015
Northampton, West Brook,	.0008	Longmeadow, Cooley Brook,	.0016
Deerfield, Roaring Brook,	.0009	Pittsfield, Sacket Brook,	.0018
Pittsfield, Mill Brook,	.0009	Springfield, Ludlow Canal,	.0020
West Springfield, Bear Hole Brook, filtered,	.0009	North Adams, Broad Brook,	.0026
Chester, Austin Brook,	.0010	Pittsfield, Ashley Brook,	.0028
Milford, Charles River, filtered,	.0010	Lee, Basin Pond Brook,	.0031
Cheshire, Thunder Brook,	.0011	Hudson, Fosgate Brook,	.0040
Chicopee, Morton Brook,	.0011	Lawrence, Merrimack River, filtered,[1]	.0047
Adams, Bassett Brook,	.0012	Lynn, Saugus River,[2]	.0057

[1] Probably derived in part from the pollution of the river water by sewage and in part from ground water, which enters the filtered water well.

[2] Free ammonia due to sewage pollution.

Table No. 10. — *Free Ammonia in the Water of Lakes and Ponds.*

[Parts in 100,000.]

Falmouth, Long Pond,	.0009	Gardner, Crystal Lake,	.0024
Maynard, White Pond,	.0011	Montague, Lake Pleasant,	.0024
Wareham, Jonathan Pond,	.0011	New Bedford, Great Quittacas Pond,	.0024
Andover, Haggett's Pond,	.0013	Abington, Big Sandy Pond,	.0025
Concord, Sandy Pond,	.0013	Fitchburg, Wachusett Lake,	.0025
Plymouth, Little South Pond,	.0013	New Bedford, Little Quittacas Pond,	.0025
Hingham, Accord Pond,	.0014	Spencer, Shaw Pond,	.0025
Plymouth, Great South Pond,	.0014	Springfield, Chapin Pond,	.0025
Brockton, Silver Lake,	.0015	Nantucket, Wannacomet Pond,	.0026
Manchester, Gravel Pond,	.0015	Hudson, Gates Pond,	.0028
Taunton, Elder's Pond,	.0015	Marlborough, Lake Williams,	.0028
Haverhill, Pentucket Lake,	.0016	Metropolitan Water District, Lake Cochituate.	.0029
Danvers, Middleton Pond,	.0018	Fitchburg, Meetinghouse Pond,	.0030
Haverhill, Johnson's Pond,	.0018	Peabody, Suntaug Lake,	.0030
Randolph, Great Pond,	.0018	Pittsfield, Ashley Lake,	.0031
Fall River, North Watuppa Lake,	.0019	Weymouth, Great Pond,	.0032
Haverhill, Crystal Lake,	.0019	Stockbridge, Lake Averic,	.0036
Holden, Muschopauge Lake,	.0019	Wakefield, Crystal Lake,	.0041
Haverhill, Lake Saltonstall,	.0020	Springfield, Five Mile Pond,	.0042
Peabody, Brown's Pond,	.0020	Salem, Wenham Lake,	.0064
Springfield, Loon Pond,	.0020	Rockport, Cape Pond,	.0074
Haverhill, Kenoza Lake,	.0022	Peabody, Spring Pond,	.0081
Taunton, Assawompsett Pond,	.0022	Cambridge, Fresh Pond,	.0087
North Andover, Great Pond,	.0023	Norwood, Buckmaster Pond,	.0110

Table No. 11. — *Free Ammonia in the Water of Storage Reservoirs.*

[Parts in 100,000.]

Hatfield, Running Gutter Brook Reservoir,	.0012	Hadley, Hart's Brook Reservoir,	.0022
Northampton, Mountain Street Reservoir,	.0012	Greenfield, Glen Brook upper reservoir,	.0023
Amherst, Amethyst Brook Reservoir,	.0016	Ipswich, Dow's Brook Reservoir,	.0023
Holyoke, Fomer Reservoir,	.0016	Metropolitan Water District, Ashland Reservoir.	.0024
Leominster, Fall Brook Reservoir,	.0017	Dalton, Egypt Brook Reservoir,	.0024
Worcester, Kent Reservoir,	.0017	Gloucester, Wallace Reservoir,	.0024
Worcester, Mann Reservoir,	.0017	Westfield, Tekoa Reservoir,	.0024
Lenox, reservoir,	.0018	Greenfield, Glen Brook lower reservoir,	.0025
Worcester, Lower Holden Reservoir,	.0019	Palmer, lower reservoir,	.0025
Northampton, Middle Reservoir,	.0020	Metropolitan Water District, Framingham Reservoir No. 3.	.0026
Worcester, Upper Holden Reservoir,	.0020	Brockton, Salisbury Brook Reservoir,	.0026
Westfield, Tillotson Brook Reservoir,	.0021	Lee, Codding Brook lower reservoir,	.0026
Metropolitan Water District, Wachusett Reservoir,	.0022	Williamsburg, reservoir,	.0027

Table No. 11. — *Free Ammonia in the Water of Storage Reservoirs* — Concluded.

[Parts in 100,000.]

Barre, reservoir,	.0028	Lee, Codding Brook upper reservoir,	.0042
Holyoke, High Service Reservoir,	.0028	Marlborough, Millham Brook Reservoir,	.0043
Metropolitan Water District, Hopkinton Reservoir.	.0029	Northborough, lower reservoir,	.0043
Gloucester, Dike's Brook Reservoir,	.0029	Holyoke, Wright and Ashley Pond,	.0044
Cambridge, Stony Brook Reservoir,	.0030	Lynn, Breed's Reservoir,	.0045
Haverhill, Millvale Reservoir,	.0030	Fitchburg, Scott Reservoir,	.0049
Springfield, Ludlow Reservoir,	.0030	Lynn, Hawkes Reservoir,	.0049
Metropolitan Water District, Framingham Reservoir No. 2.	.0031	North Brookfield, Doane Pond,	.0050
Northbridge, Cook Allen Reservoir,	.0031	Wayland, Snake Brook Reservoir,	.0056
Worcester, Bottomly Reservoir,	.0031	Lynn, Birch Reservoir,	.0058
Metropolitan Water District, Sudbury Reservoir.	.0032	North Brookfield, North Pond,	.0060
Cambridge, Lower Hobbs Brook Reservoir,	.0032	South Hadley, Leaping Well Reservoir,	.0063
Leominster, Morse Reservoir,	.0032	South Hadley, Buttery Brook Reservoir,	.0066
Athol, Buckman Brook Reservoir,	.0033	West Springfield, Darby Brook Reservoir,	.0066
North Adams, Notch Brook Reservoir,	.0034	Winchester, South Reservoir,	.0068
Southbridge, Hatchet Brook Reservoir No. 3.	.0037	Winchester, Middle Reservoir,	.0070
Worcester, Leicester Reservoir,	.0038	Lynn, Walden Reservoir,	.0071
Great Barrington, East Mountain Reservoir,	.0040	Leominster, Haynes Reservoir,	.0076
Holyoke, Whiting Street Reservoir,	.0040	Southbridge, Hatchet Brook Reservoir No. 4.	.0094
Cambridge, Upper Hobbs Brook Reservoir,	.0041	Gloucester, Haskell Brook Reservoir,	.0095
Westfield, Montgomery Reservoir,	.0041	Athol, Phillipston Reservoir,	.0096
Winchester, North Reservoir,	.0041	Salem, Longham Reservoir,	.0103

Color of Surface Waters.

The color of surface waters is due mainly to the extraction of soluble coloring matter from leaves, grass, peat, etc., and long contact with vegetable matter in swamps imparts to some of the waters a very high color. Many of the surface waters used as sources of water supply in the State are more or less colored by vegetable matter. Waters derived from steep watersheds, such as those of the mountain streams in the westerly part of the State, are for the most part nearly colorless, as are also the waters of streams which are fed largely by springs. The waters of some ponds and reservoirs, though receiving through their tributary streams waters having a very high color, are nearly colorless, the color having been removed from the water by bleaching, chiefly due to exposure to sunlight for a long period. The average color of the various water supplies in the State during the past five years is given in Table No. 12, and for convenience this table has been divided so as to show the comparative color of the waters of streams, natural ponds and storage reservoirs.

TABLE No. 12. — *Color of Surface Waters.*

[Parts in 100,000.]

Plymouth, Great South Pond,	0.01	Holyoke, Whiting Street Reservoir,	0.11
Wareham, Jonathan Pond,	0.01	Manchester, Gravel Pond,	0.11
Great Barrington, Green River,	0.02	Marlborough, Lake Williams,	0.11
Plymouth, Little South Pond,	0.02	Taunton, Elder's Pond,	0.11
Adams, Basset Brook,	0.03	Metropolitan Water District, tap in Revere,	0.12
Cheshire, Kitchen Brook,	0.03	Chester, Austin Brook,	0.12
Falmouth, Long Pond,	0.03	Hadley, Hart's Brook Reservoir,	0.12
Concord, Sandy Pond,	0.04	Hudson, Gates Pond,	0.12
Pittsfield, Hathaway Brook,	0.04	Pittsfield, Sacket Brook,	0.12
Montague, Lake Pleasant,	0.05	Metropolitan Water District, Spot Pond,	0.13
Springfield, Loon Pond,	0.05	Fitchburg, Wachusett Lake,	0.13
Cheshire, Thunder Brook,	0.06	Haverhill, Pentucket Lake,	0.13
North Adams, Notch Brook Reservoir,	0.06	Leominster, Fall Brook Reservoir,	0.13
Peabody, Suntaug Lake,	0.06	Northampton, West Brook,	0.13
Springfield, Chapin Pond,	0.06	Stockbridge, Lake Averic,	0.13
West Springfield, Bear Hole Brook, filtered,	0.06	Maynard, White Pond,	0.14
Blandford, Freeland Brook,	0.07	Norwood, Buckmaster Pond,	0.14
Deerfield, Roaring Brook,	0.07	Winchester, South Reservoir,	0.14
Greenfield, Glen Brook lower reservoir,	0.07	Andover, Haggett's Pond,	0.15
Holden, Muschopauge Lake,	0.07	Huntington, Cold Brook,	0.15
Chicopee, Morton Brook,	0.08	North Andover, Great Pond,	0.15
Greenfield, Glen Brook upper reservoir,	0.08	Pittsfield, Mill Brook,	0.15
Haverhill, Lake Saltonstall,	0.08	Worcester, Upper Holden Reservoir,	0.15
Longmeadow, Cooley Brook,	0.08	Cambridge, Lower Hobbs Brook Reservoir,	0.16
Spencer, Shaw Pond,	0.08	Haverhill, Johnson's Pond,	0.16
Fitchburg, Meetinghouse Pond,	0.09	Haverhill, Kenoza Lake,	0.16
Gardner, Crystal Lake,	0.09	Peabody, Brown's Pond,	0.16
Lenox, reservoir,	0.09	Winchester, Middle Reservoir,	0.16
Nantucket, Wannacomet Pond,	0.09	Metropolitan Water District, Weston Reservoir.	0.17
Peabody, Spring Pond,	0.09	Fitchburg, Scott Reservoir,	0.17
Winchester, North Reservoir,	0.09	South Hadley, Buttery Brook Reservoir.	0.17
Worcester, Lower Holden Reservoir,	0.09	Worcester, Kent Reservoir,	0.17
Abington, Big Sandy Pond,	0.10	Metropolitan Water District, Wachusett Reservoir.	0.18
Holyoke, Wright and Ashley Pond,	0.10	Metropolitan Water District, Framingham Reservoir No. 3.	0.18
Northampton, Mountain Street Reservoir,	0.10	Metropolitan Water District, Tap in Quincy,	0.18
South Hadley, Leaping Well Reservoir,	0.10	Barre, reservoir,	0.18
Springfield, Five Mile Pond,	0.10	Holyoke, High Service Reservoir,	0.18
Brockton, Silver Lake,	0.11	North Adams, Broad Brook,	0.18
Great Barrington, East Mountain Reservoir,	0.11	Westfield, Tillotson Brook Reservoir,	0.18
Hatfield, Running Gutter Brook Reservoir,	0.11	Metropolitan Water District, Sudbury Reservoir.	0.19

TABLE No. 12. — *Color of Surface Waters* — Concluded.

[Parts in 100,000.]

Hingham, Accord Pond,	0.19
Pittsfield, Ashley Brook,	0.19
Worcester, Mann Reservoir,	0.19
Adams, Dry Brook,	0.20
Fall River, North Watuppa Lake,	0.20
Haverhill, Crystal Lake,	0.20
Lee, Codding Brook lower reservoir,	0.20
Leominster, Morse Reservoir,	0.20
Wakefield, Crystal Lake,	0.20
Worcester, Leicester Reservoir,	0.20
Metropolitan Water District, Chestnut Hill Reservoir.	0.21
Metropolitan Water District, tap in State House.	0.21
Ipswich, Dow's Brook Reservoir,	0.21
Milford, Charles River, filtered,	0.21
Williamsburg, reservoir,	0.21
Leominster, Haynes Reservoir,	0.22
West Springfield, Darby Brook Reservoir,	0.22
Metropolitan Water District, Lake Cochituate.	0.24
Salem, Wenham Lake,	0.24
Springfield, Ludlow Basin,	0.24
Stoughton, Muddy Pond Brook,	0.24
Ashfield, Bear Swamp Brook,	0.25
Cambridge, Fresh Pond,	0.25
Palmer, lower reservoir,	0.25
Amherst, Amethyst Brook Reservoir,	0.26
Rockport, Cape Pond,	0.26
Holyoke, Fomer Reservoir,	0.27
Lee, Codding Brook upper reservoir,	0.27
Northampton, Middle Reservoir,	0.27
Northbridge, Cook Allen Reservoir,	0.27
Springfield, Ludlow Reservoir,	0.27
Worcester, Bottomly Reservoir,	0.27
Athol, Buckman Brook Reservoir,	0.30
Easthampton, Bassett Brook,	0.30
New Bedford, Little Quittacas Pond,	0.30
Pittsfield, Ashley Lake,	0.30
Dalton, Egypt Brook Reservoir,	0.32
Taunton, Assawompsett Pond,	0.32
Chicopee, Cooley Brook,	0.34
Lynn, Birch Reservoir,	0.35
Lawrence, Merrimack River, filtered,	0.36
Westfield, Tekoa Reservoir,	0.38
Cambridge, Stony Brook Reservoir,	0.39
Lee, Basin Pond Brook,	0.39
Southbridge, Hatchet Brook Reservoir No. 3.	0.40
Gloucester, Dike's Brook Reservoir,	0.41
Lynn, Breed's Reservoir,	0.42
Westfield, Montgomery Reservoir,	0.42
Randolph, Great Pond,	0.43
Gloucester, Wallace Reservoir,	0.44
Hudson, Fosgate Brook,	0.44
Springfield, Ludlow Canal,	0.44
Lynn, Walden Reservoir,	0.45
New Bedford, Great Quittacas Pond,	0.45
Southbridge, Hatchet Brook Reservoir No. 4.	0.47
Marlborough, Millham Brook Reservoir,	0.49
North Brookfield, Doane Pond,	0.49
North Brookfield, North Pond,	0.49
Brockton, Salisbury Brook Reservoir,	0.51
Cambridge, Upper Hobbs Brook Reservoir,	0.52
Danvers, Middleton Pond,	0.52
Gloucester, Haskell Brook Reservoir,	0.53
Lynn, Hawkes Reservoir,	0.55
Metropolitan Water District, Hopkinton Reservoir.	0.57
Athol, Phillipston Reservoir,	0.57
Metropolitan Water District, Ashland Reservoir.	0.60
Haverhill, Millvale Reservoir,	0.61
Northborough, lower reservoir,	0.64
Weymouth, Great Pond,	0.68
Metropolitan Water District, Framingham Reservoir No. 2.	0.69
Wayland, Snake Brook Reservoir,	0.73
Lynn, Saugus River,	0.94
Salem, Longham Reservoir,	1.04

Table No. 13. — *Color of the Water of Streams.*

[Parts in 100,000.]

Great Barrington, Green River,	.02	Pittsfield, Mill Brook,	.15
Adams, Bassett Brook,	.03	North Adams, Broad Brook,	.18
Cheshire, Kitchen Brook,	.03	Pittsfield, Ashley Brook,	.19
Pittsfield, Hathaway Brook,	.04	Adams, Dry Brook,	.20
Cheshire, Thunder Brook,	.06	Milford, Charles River, filtered,	.21
West Springfield, Bear Hole Brook, filtered,	.06	Stoughton, Muddy Pond Brook,	.24
Blandford, Freeland Brook,	.07	Ashfield, Bear Swamp Brook,	.25
Deerfield, Roaring Brook,	.07	Easthampton, Bassett Brook,	.30
Chicopee, Morton Brook,	.08	Chicopee, Cooley Brook,	.34
Longmeadow, Cooley Brook,	.08	Lawrence, Merrimack River, filtered,	.36
Chester, Austin Brook,	.12	Lee, Basin Pond Brook,	.39
Pittsfield, Sacket Brook,	.12	Hudson, Fosgate Brook,	.44
Northampton, West Brook,	.13	Springfield, Ludlow Canal,	.44
Huntington, Cold Brook,	.15	Lynn, Saugus River,	.94

Table No. 14. — *Color of the Water of Lakes and Ponds.*

[Parts in 100,000.]

Plymouth, Great South Pond,	.01	Haverhill, Pentucket Lake,	.13
Wareham, Jonathan Pond,	.01	Stockbridge, Lake Averic,	.13
Plymouth, Little South Pond,	.02	Maynard, White Pond,	.14
Falmouth, Long Pond,	.03	Norwood, Buckmaster Pond,	.14
Concord, Sandy Pond,	.04	Andover, Haggett's Pond,	.15
Montague, Lake Pleasant,	.05	North Andover, Great Pond,	.15
Springfield, Loon Pond,	.05	Haverhill, Johnson's Pond,	.16
Peabody, Suntaug Lake,	.06	Haverhill, Kenoza Lake,	.16
Springfield, Chapin Pond,	.06	Peabody, Brown's Pond,	.16
Holden, Muschopauge Lake,	.07	Hingham, Accord Pond,	.19
Haverhill, Lake Saltonstall,	.08	Fall River, North Watuppa Lake,	.20
Spencer, Shaw Pond,	.08	Haverhill, Crystal Lake,	.20
Fitchburg, Meetinghouse Pond,	.09	Wakefield, Crystal Lake,	.20
Gardner, Crystal Lake,	.09	Metropolitan Water District, Lake Cochituate,	.24
Nantucket, Wannacomet Pond,	.09	Salem, Wenham Lake,	.24
Peabody, Spring Pond,	.09	Cambridge, Fresh Pond,	.25
Abington, Big Sandy Pond,	.10	Rockport, Cape Pond,	.26
Springfield, Five Mile Pond,	.10	New Bedford, Little Quittacas Pond,	.30
Brockton, Silver Lake,	.11	Pittsfield, Ashley Lake,	.30
Manchester, Gravel Pond,	.11	Taunton, Assawompsett Pond,	.32
Marlborough, Lake Williams,	.11	Randolph, Great Pond,	.43
Taunton, Elder's Pond,	.11	New Bedford, Great Quittacas Pond,	.45
Hudson, Gates Pond,	.12	Danvers, Middleton Pond,	.52
Fitchburg, Wachusett Lake,	.13	Weymouth, Great Pond,	.68

TABLE NO. 15. — *Color of the Water of Storage Reservoirs.*

[Parts in 100,000.]

North Adams, Notch Brook Reservoir,	.06	Palmer, lower reservoir,	.25
Greenfield, Glen Brook lower reservoir,	.07	Amherst, Amethyst Brook Reservoir,	.26
Greenfield, Glen Brook upper reservoir,	.08	Holyoke, Fomer Reservoir,	.27
Lenox, reservoir,	.09	Lee. Codding Brook upper reservoir,	.27
Winchester, North Reservoir,	.09	Northampton, Middle Reservoir,	.27
Worcester, Lower Holden Reservoir,	.09	Northbridge, Cook Allen Reservoir,	.27
Holyoke, Wright and Ashley Pond,	.10	Springfield, Ludlow Reservoir,	.27
Northampton, Mountain Street Reservoir,	.10	Worcester, Bottomly Reservoir,	.27
South Hadley, Leaping Well Reservoir,	.10	Athol, Buckman Brook Reservoir,	.30
Great Barrington, East Mountain Reservoir,	.11	Dalton, Egypt Brook Reservoir,	.32
Hatfield, Running Gutter Brook Reservoir,	.11	Lynn, Birch Reservoir,	.35
Holyoke, Whiting Street Reservoir,	.11	Westfield, Tekoa Reservoir,	.38
Hadley, Hart's Brook Reservoir,	.12	Cambridge, Stony Brook Reservoir,	.39
Leominster, Fall Brook Reservoir,	.13	Southbridge, Hatchet Brook Reservoir No. 3,	.40
Winchester, South Reservoir,	.14	Gloucester, Dike's Brook Reservoir,	.41
Worcester, Upper Holden Reservoir,	.15	Lynn, Breed's Reservoir,	.42
Cambridge, Lower Hobbs Brook Reservoir,	.16	Westfield, Montgomery Reservoir,	.42
Winchester, Middle Reservoir,	.16	Gloucester, Wallace Reservoir,	.44
Fitchburg, Scott Reservoir,	.17	Lynn, Walden Reservoir,	.45
South Hadley, Buttery Brook Reservoir,	.17	Southbridge, Hatchet Brook Reservoir No. 4,	.47
Worcester, Kent Reservoir,	.17	Marlborough, Millham Brook Reservoir,	.49
Metropolitan Water District, Wachusett Reservoir.	.18	North Brookfield, Doane Pond,	.49
Metropolitan Water District, Framingham Reservoir No. 3.	.18	North Brookfield, North Pond,	.49
Barre, reservoir,	.18	Brockton, Salisbury Brook Reservoir,	.51
Holyoke, High Service Reservoir,	.18	Cambridge, Upper Hobbs Brook Reservoir,	.52
Westfield, Tillotson Brook Reservoir,	.18	Gloucester, Haskell Brook Reservoir,	.53
Metropolitan Water District, Sudbury Reservoir.	.19	Lynn, Hawkes Reservoir,	.55
Worcester, Mann Reservoir,	.19	Metropolitan Water District, Hopkinton Reservoir.	.57
Lee, Codding Brook lower reservoir,	.20	Athol, Phillipston Reservoir,	.57
Leominster, Morse Reservoir,	.20	Metropolitan Water District, Ashland Reservoir.	.60
Worcester, Leicester Reservoir,	.20	Haverhill, Millvale Reservoir,	.61
Ipswich, Dow's Brook Reservoir,	.21	Northborough, lower reservoir,	.64
Williamsburg, reservoir,	.21	Metropolitan Water District, Framingham Reservoir No. 2.	.69
Leominster, Haynes Reservoir,	.22	Wayland, Snake Brook Reservoir,	.73
West Springfield, Darby Brook Reservoir,	.22	Salem, Longham Reservoir,	1.04

Hardness of Surface Waters.

The waters which have the greatest hardness are those in the limestone regions, located chiefly in the westerly part of the State, and those derived from populous districts. From the following table, which gives the average hardness of the various surface-water supplies in the State during the past five years, it will be seen that the waters having the highest hardness are all located in Berkshire County, the only waters in the eastern part of the State having an average hardness in excess of 2.5 parts in 100,000 being Fresh Pond, one of the sources of water supply of the city of Cambridge, and the Saugus River, used as a source of water supply by the city of Lynn. Fresh Pond has probably been affected somewhat by sea water and considerably by the large population living in its neighborhood, while the hardness of the Saugus River water is caused by pollution from the very large population living within its watershed.

Table No. 16. — *Hardness of Surface Waters.*

[Parts in 100,000.]

Wareham, Jonathan Pond,	0.0	North Brookfield, North Pond,	0.5
Plymouth, Little South Pond,	0.1	Taunton, Assawompsett Pond,	0.5
Plymouth, Great South Pond,	0.1	Taunton, Elder's Pond,	0.5
Leominster, Haynes Reservoir,	0.2	Westfield, Tillotson Brook Reservoir,	0.5
Leominster, Morse Reservoir,	0.2	Weymouth, Great Pond,	0.5
Falmouth, Long Pond,	0.3	Athol, Buckman Brook Reservoir,	0.6
Gloucester, Dike's Brook Reservoir,	0.3	New Bedford, Great Quittacas Pond,	0.6
Leominster, Fall Brook Reservoir,	0.3	Southbridge, Hatchet Brook Reservoir No. 4,	0.6
Northbridge, Cook Allen Reservoir,	0.3	Worcester, Lower Holden Reservoir,	0.6
Westfield, Montgomery Reservoir,	0.3	Blandford, Freeland Brook,	0.7
Westfield, Tekoa Reservoir,	0.3	Fall River, North Watuppa Pond,	0.7
Fitchburg, Scott Reservoir,	0.4	Fitchburg, Meetinghouse Pond,	0.7
Fitchburg, Wachusett Lake,	0.4	Hudson, Gates Pond,	0.7
Gloucester, Wallace Reservoir,	0.4	Lee, Codding Brook upper reservoir,	0.7
Gloucester, Haskell Brook Reservoir,	0.4	New Bedford, Little Quittacas Pond,	0.7
Hingham, Accord Pond,	0.4	Palmer, lower reservoir,	0.7
Montague, Lake Pleasant,	0.4	Southbridge, Hatchet Brook Reservoir No. 3,	0.7
Springfield, Chapin Pond,	0.4	South Hadley, Leaping Well Reservoir,	0.7
Springfield, Five Mile Pond,	0.4	Stoughton, Muddy Pond Brook,	0.7
Worcester, Upper Holden Reservoir,	0.4	Metropolitan Water District, Wachusett Reservoir.	0.8
Abington, Big Sandy Pond,	0.5	Brockton, Salisbury Brook Reservoir,	0.8
Amherst, Amethyst Brook Reservoir,	0.5	Chicopee, Morton Brook,	0.8
Athol, Phillipston Reservoir,	0.5	Concord, Sandy Pond,	0.8
Brockton, Silver Lake,	0.5	Maynard, White Pond,	0.8
North Brookfield, Doane Pond,	0.5	South Hadley, Buttery Brook Reservoir,	0.8

Table No. 16. — *Hardness of Surface Waters* — Continued.

[Parts in 100,000.]

Springfield, Ludlow Reservoir,	0.8
Springfield, Loon Pond,	0.8
Metropolitan Water District, Hopkinton Reservoir.	0.9
Metropolitan Water District, Ashland Reservoir.	0.9
Barre, reservoir,	0.9
Holden, Muschopauge Lake,	0.9
Manchester, Gravel Pond,	0.9
Northborough, lower reservoir,	0.9
Peabody, Brown's Pond,	0.9
Spencer, Shaw Pond,	0.9
Springfield, Ludlow Basin,	0.9
Worcester, Leicester Reservoir,	0.9
Metropolitan Water District, Framingham Reservoir No. 2.	1.0
Chicopee, Cooley Brook,	1.0
Dalton, Egypt Brook Reservoir,	1.0
Haverhill, Crystal Lake,	1.0
Huntington, Cold Brook,	1.0
Norwood, Buckmaster Pond,	1.0
Randolph, Great Pond,	1.0
Springfield, Ludlow Canal,	1.0
Metropolitan Water District, Sudbury Reservoir.	1.1
Metropolitan Water District, Framingham Reservoir No. 3.	1.1
Metropolitan Water District, Chestnut Hill Reservoir.	1.1
Andover, Haggett's Pond,	1.1
Milford, Charles River, filtered,	1.1
Nantucket, Wannacomet Pond,	1.1
Worcester, Bottomly Reservoir,	1.1
Worcester, Kent Reservoir,	1.1
Worcester, Mann Reservoir,	1.1
Metropolitan Water District, Weston Reservoir.	1.2
Danvers, Middleton Pond,	1.2
Lynn, Breed's Reservoir,	1.2
Winchester, South Reservoir,	1.2
Metropolitan Water District, Spot Pond,	1.3
Metropolitan Water District, tap in State House.	1.3
Metropolitan Water District, tap in Revere,	1.3
Metropolitan Water District, tap in Quincy,	1.3
Easthampton, Bassett Brook,	1.3
Marlborough, Millham Brook Reservoir,	1.3
Winchester, Middle Reservoir,	1.3
Chester, Austin Brook,	1.4
Lawrence, Merrimack River, filtered,	1.4
Lynn, Birch Reservoir,	1.4
North Andover, Great Pond,	1.4
Holyoke, Fomer Reservoir,	1.5
Hudson, Fosgate Brook,	1.5
Marlborough, Lake Williams,	1.5
Wayland, Snake Brook Reservoir,	1.5
Williamsburg, reservoir,	1.5
Gardner, Crystal Lake,	1.6
Lee, Codding Brook lower reservoir,	1.6
Lynn, Walden Reservoir,	1.6
Northampton, Middle Reservoir,	1.6
Rockport, Cape Pond,	1.6
Winchester, North Reservoir,	1.6
Hatfield, Running Gutter Brook Reservoir,	1.7
Haverhill, Kenoza Lake,	1.7
Haverhill, Millvale Reservoir,	1.7
Northampton, Mountain Street Reservoir,	1.7
Haverhill, Pentucket Lake,	1.8
Ipswich, Dow's Brook Reservoir,	1.8
Northampton, West Brook,	1.8
Wakefield, Crystal Lake,	1.8
Haverhill, Johnson's Pond,	1.9
Lynn, Hawkes Reservoir,	1.9
Peabody, Suntaug Lake,	1.9
Salem, Longham Reservoir,	1.9
Metropolitan Water District, Lake Cochituate.	2.0
Cambridge, Upper Hobbs Brook Reservoir,	2.1
Cambridge, Lower Hobbs Brook Reservoir,	2.1
Cambridge, Stony Brook Reservoir,	2.1
Lee, Basin Pond Brook,	2.1
Salem, Wenham Lake,	2.1
Holyoke, High Service Reservoir,	2.2
North Adams, Broad Brook,	2.2
Hadley, Hart's Brook Reservoir,	2.3
Holyoke, Whiting Street Reservoir,	2.3
Peabody, Spring Pond,	2.3
West Springfield, Darby Brook Reservoir,	2.3
Haverhill, Lake Saltonstall,	2.4

TABLE No. 16. — *Hardness of Surface Waters* — Concluded.

[Parts in 100,000.]

Pittsfield, Ashley Lake,	2.6	Cheshire, Thunder Brook,	3.8
Ashfield, Bear Swamp Brook,	2.7	Pittsfield, Mill Brook,	3.9
Holyoke, Wright and Ashley Pond,	2.7	West Springfield, Bear Hole Brook, filtered,	4.0
Cambridge, Fresh Pond,	2.9	Stockbridge, Lake Averic,	4.1
Longmeadow, Cooley Brook,	2.9	Pittsfield, Ashley Brook,	4.2
Greenfield, Glen Brook lower reservoir,	3.0	Lenox, reservoir,	5.1
Adams, Bassett Brook,	3.1	North Adams, Notch Brook Reservoir,	5.4
Greenfield, Glen Brook upper reservoir,	3.1	Pittsfield, Sacket Brook,	5.8
Deerfield, Roaring Brook,	3.6	Adams, Dry Brook,	6.3
Great Barrington, East Mountain Reservoir,	3.6	Great Barrington, Green River,	7.3
Cheshire, Kitchen Brook,	3.7	Pittsfield, Hathaway Brook,	9.2
Lynn, Saugus River,	3.7		

NITRATES IN SURFACE WATERS.

Although the determination of nitrates is of much less importance in surface waters than in ground waters, it serves, however, in a general way as an index of pollution, especially in the streams, and to a less extent in the larger ponds and storage reservoirs, since under the latter conditions they are quickly absorbed by growing organisms. The average quantity of nitrates present in the various surface-water supplies in the State during the past five years is given in the following table: —

TABLE No. 17. — *Nitrates in Surface Waters.*

[Parts in 100,000.]

Plymouth, Great South Pond,	.0003	Hingham, Accord Pond,	.0011
Manchester, Gravel Pond,	.0004	Leominster, Haynes Reservoir,	.0011
New Bedford, Great Quittacas Pond,	.0006	Southbridge, Hatchet Brook Reservoir No. 4.	.0011
Hadley, Hart's Brook Reservoir,	.0007	Abington, Big Sandy Pond,	.0012
Plymouth, Little South Pond,	.0007	Taunton, Assawompsett Pond,	.0012
New Bedford, Little Quittacas Pond,	.0008	Brockton, Salisbury Brook Reservoir,	.0013
Brockton, Silver Lake,	.0009	Northbridge, Cook Allen Reservoir,	.0013
Fitchburg, Wachusett Lake,	.0009	Wareham, Jonathan Pond,	.0013
Gloucester, Wallace Reservoir,	.0009	Barre, reservoir,	.0014
Leominster, Fall Brook Reservoir,	.0009	Haverhill, Lake Saltonstall,	.0014
Taunton, Elder's Pond,	.0009	Holyoke, Whiting Street Reservoir,	.0014
Falmouth, Long Pond,	.0010	Huntington, Cold Brook,	.0014
Haverhill, Pentucket Lake,	.0010	Springfield, Ludlow Basin,	0014
Nantucket, Wannacomet Pond,	.0010	Winchester, North Reservoir,	.0014
Danvers, Middleton Pond,	.0011	Andover, Haggett's Pond,	.0015

TABLE No. 17. — *Nitrates in Surface Waters* — Continued.

[Parts in 100,000.]

Gloucester, Dike's Brook Reservoir,	.0015	North Brookfield, Doane Pond,	.0024
Haverhill, Crystal Lake,	.0015	Cambridge, Lower Hobbs Brook Reservoir,	.0025
Springfield, Chapin Pond,	.0015	Lynn, Birch Reservoir,	.0025
Springfield, Loon Pond,	.0015	Peabody, Suntaug Lake,	.0025
Westfield, Montgomery Reservoir,	.0015	Stockbridge, Lake Averic,	.0025
Great Barrington, East Mountain Reservoir.	.0016	Westfield, Tillotson Brook Reservoir,	.0026
Haverhill, Johnson's Pond,	.0016	Metropolitan Water District, Ashland Reservoir.	.0027
North Andover, Great Pond,	.0016	Metropolitan Water District, Lake Cochituate.	.0027
Springfield, Five Mile Pond,	.0016	Lynn, Breed's Reservoir,	.0027
Westfield, Tekoa Reservoir,	.0016	Lynn, Saugus River,	.0027
Williamsburg, reservoir,	.0016	Athol, Buckman Brook Reservoir,	.0028
Metropolitan Water District, Spot Pond,	.0017	Holyoke, High Service Reservoir,	.0028
Rockport, Cape Pond,	.0017	Lynn, Hawkes Reservoir,	.0028
Fall River, North Watuppa Pond,	.0018	North Brookfield, North Pond,	.0028
Fitchburg, Meetinghouse Pond,	.0018	Holyoke, Fomer Reservoir,	.0030
Haverhill, Kenoza Lake,	.0018	Chicopee, Morton Brook,	.0031
Marlborough, Lake Williams,	.0018	Ipswich, Dow's Brook Reservoir,	.0031
Concord, Sandy Pond,	.0019	Spencer, Shaw Pond,	.0031
Holyoke, Wright and Ashley Pond,	.0019	Chicopee, Cooley Brook,	.0032
Leominster, Morse Reservoir,	.0019	Lynn, Walden Reservoir,	.0032
Springfield, Ludlow Reservoir,	.0019	Northampton, Middle Reservoir,	.0032
Northampton, Mountain Street Reservoir,	.0019	Springfield, Ludlow Canal,	.0032
Winchester, Middle Reservoir,	.0019	Metropolitan Water District, Framingham Reservoir No. 2.	.0033
Gloucester, Haskell Brook Reservoir,	.0020	Holden, Muschopauge Lake,	.0033
Haverhill, Millvale Reservoir,	.0020	Northborough, lower reservoir,	.0034
Worcester, Upper Holden Reservoir,	.0020	West Springfield, Bear Hole Brook, filtered,	.0036
Worcester, Lower Holden Reservoir,	.0020	Athol, Phillipston Reservoir,	.0038
Ashfield, Bear Swamp Brook,	.0021	Lee, Codding Brook upper reservoir,	.0038
North Adams, Notch Brook Reservoir,	.0021	Gardner, Crystal Lake,	.0039
Southbridge, Hatchet Brook Reservoir No. 3.	.0021	Randolph, Great Pond,	.0039
Winchester, South Reservoir,	.0021	Metropolitan Water District, Framingham Reservoir No. 3.	.0040
Metropolitan Water District, tap in Revere,	.0022	Northampton, West Brook,	.0040
Hudson, Gates Pond,	.0022	Pittsfield, Ashley Lake,	.0041
Montague, Lake Pleasant,	.0022	Metropolitan Water District, Hopkinton Reservoir.	.0042
Palmer, lower reservoir,	.0022	Lee, Basin Pond Brook,	.0043
Weymouth, Great Pond,	.0022	South Hadley, Leaping Well Reservoir,	.0043
Amherst, Amethyst Brook Reservoir,	.0023	Worcester, Leicester Reservoir,	.0043
Fitchburg, Scott Reservoir,	.0023	Metropolitan Water District, Sudbury Reservoir.	.0044
Norwood, Buckmaster Pond,	.0023	Lee, Codding Brook lower reservoir,	.0044
Metropolitan Water District, Wachusett Reservoir.	.0024	Peabody, Brown's Pond,	.0044

TABLE No. 17. — *Nitrates in Surface Waters* — Concluded.

[Parts in 100,000.]

Stoughton, Muddy Pond Brook,	.0044	Hudson, Fosgate Brook,	.0069
Salem, Wenham Lake,	.0045	Salem, Longham Reservoir,	.0070
Pittsfield, Ashley Brook,	.0047	West Springfield, Darby Brook Reservoir,	.0070
Metropolitan Water District, Chestnut Hill Reservoir.	.0048	Metropolitan Water District, tap in Quincy,	.0076
Adams, Dry Brook,	.0050	Adams, Bassett Brook,	.0077
Chester, Austin Brook,	.0051	Wayland, Snake Brook Reservoir,	.0089
Lenox, reservoir,	.0051	Deerfield, Roaring Brook,	.0092
Maynard, White Pond,	.0051	Cambridge, Stony Brook Reservoir,	.0105
Pittsfield, Mill Brook,	.0051	Worcester, Bottomly Reservoir,	.0108
Wakefield, Crystal Lake,	.0051	Pittsfield, Sacket Brook,	.0115
Peabody, Spring Pond,	.0052	Pittsfield, Hathaway Brook,	.0124
Metropolitan Water District, Weston Reservoir.	.0053	North Adams, Broad Brook,	.0126
Easthampton, Bassett Brook,	.0055	Blandford, Freeland Brook,	.0137
Cheshire, Kitchen Brook,	.0056	Great Barrington, Green River,	.0137
Greenfield, Glen Brook upper reservoir,	.0056	Cambridge, Fresh Pond,	.0145
Cheshire, Thunder Brook,	.0059	Milford, Charles River, filtered,	.0155
Marlborough, Millham Brook Reservoir,	.0059	Dalton, Egypt Brook Reservoir,	.0160
Worcester, Kent Reservoir,	.0059	Hatfield, Running Gutter Brook Reservoir,	.0175
Worcester, Mann Reservoir,	.0062	Longmeadow, Cooley Brook,	.0266
Greenfield, Glen Brook lower reservoir,	.0065	South Hadley, Buttery Brook Reservoir,	.0266
Metropolitan Water District, tap in State House.	.0066	Lawrence, Merrimack River, filtered,	.0374
Cambridge, Upper Hobbs Brook Reservoir,	.0067		

RESIDUE ON EVAPORATION IN SURFACE WATERS.

The quantity of dissolved mineral matter found in the waters of the State is generally greatest in the waters of Pittsfield, Great Barrington, Lenox, Adams, North Adams and other towns in the westerly part of the State, where many of the waters dissolve limestone from the rocks and soil over which they flow. It is also large in the ponds and storage reservoirs nearest the sea. Except in these cases a high total residue is usually an indication of sewage pollution. The highest total residue found in the surface waters in the easterly part of the State is in the waters of Cape Pond, the source of water supply of the town of Rockport, and the Saugus River, used as a source of water supply by the city of Lynn. While the high residue in the water of Cape Pond may be due in some measure to its nearness to the ocean, it is probably mainly due to pollution by wastes from a glue factory. The high residue in the water of the Saugus River is due to pollution from a large population on its watershed. The total residue on evaporation in the various surface-water supplies of the State is shown in the following table: —

TABLE No. 18. — *Residue on Evaporation in Surface Waters.*

[Parts in 100,000.]

Springfield, Chapin Pond,	2.34
Wareham, Jonathan Pond,	2.35
Montague, Lake Pleasant,	2.38
Worcester, Upper Holden Reservoir,	2.42
Worcester, Lower Holden Reservoir,	2.42
Leominster, Morse Reservoir,	2.45
Leominster, Fall Brook Reservoir,	2.48
Plymouth, Little South Pond,	2.51
Fitchburg, Wachusett Lake,	2.52
Springfield, Five Mile Pond,	2.55
Lee, Codding Brook upper reservoir,	2.57
Westfield, Montgomery Reservoir,	2.64
Fitchburg, Meetinghouse Pond,	2.65
Fitchburg, Scott Reservoir,	2.68
Leominster, Haynes Reservoir,	2.68
Concord, Sandy Pond,	2.75
Plymouth, Great South Pond,	2.77
Holden, Muschopauge Lake,	2.78
Hudson, Gates Pond,	2.81
Westfield, Tekoa Reservoir,	2.81
South Hadley, Leaping Well Reservoir,	2.84
Spencer, Shaw Pond,	2.84
Northbridge, Cook Allen Reservoir,	2.85
Falmouth, Long Pond,	2.93
Springfield, Ludlow Reservoir,	2.97
Huntington, Cold Brook,	2.99
Springfield, Loon Pond,	2.99
Blandford, Freeland Brook,	3.02
Springfield, Ludlow Basin,	3.02
Metropolitan Water District, Wachusett Reservoir.	3.03
North Brookfield, North Pond,	3.03
Taunton, Elder's Pond,	3.04
Barre, reservoir,	3.08
Westfield, Tillotson Brook Reservoir,	3.08
Amherst, Amethyst Brook Reservoir,	3.09
Hingham, Accord Pond,	3.12
Worcester, Leicester Reservoir,	3.14
Maynard, White Pond,	3.16
Abington, Big Sandy Pond,	3.17
Stoughton, Muddy Pond Brook,	3.17
North Brookfield, Doane Pond,	3.18
Southbridge, Hatchet Brook Reservoir No. 3,	3.19
Dalton, Egypt Brook Reservoir,	3.24
Brockton, Silver Lake,	3.27
Athol, Buckman Brook Reservoir,	3.29
Andover, Haggett's Pond,	3.31
Metropolitan Water District, Sudbury Reservoir.	3.32
Metropolitan Water District, Framingham Reservoir No. 3.	3.32
Haverhill, Crystal Lake,	3.33
Southbridge, Hatchet Brook Reservoir No. 4,	3.37
Worcester, Kent Reservoir,	3.38
Taunton, Assawompsett Pond,	3.41
Palmer, lower reservoir,	3.42
Athol, Phillipston Reservoir,	3.45
Metropolitan Water District, Chestnut Hill Reservoir.	3.49
Metropolitan Water District, Spot Pond,	3.49
Chester, Austin Brook,	3.50
Metropolitan Water District, Weston Reservoir.	3.51
Winchester, South Reservoir,	3.51
Lee, Codding Brook lower reservoir,	3.53
New Bedford, Great Quittacas Pond,	3.57
Metropolitan Water District, tap in Revere,	3.61
Milford, Charles River, filtered,	3.66
Winchester, Middle Reservoir,	3.67
Metropolitan Water District, tap in Quincy,	3.68
New Bedford, Little Quittacas Pond,	3.69
Peabody, Brown's Pond,	3.71
Metropolitan Water District, tap in State House.	3.72
North Andover, Great Pond,	3.72
Springfield, Ludlow Canal,	3.74
Worcester, Mann Reservoir,	3.74
Worcester, Bottomly Reservoir,	3.76
Fall River, North Watuppa Lake,	3.79
Norwood, Buckmaster Pond,	3.79
Northampton, Mountain Street Reservoir,	3.82
Williamsburg, reservoir,	3.82
South Hadley, Buttery Brook Reservoir,	3.85
Winchester, North Reservoir,	3.93

TABLE NO. 18. — *Residue on Evaporation in Surface Waters* — Concluded.

[Parts in 100,000.]

Metropolitan Water District, Ashland Reservoir.	3.94
Metropolitan Water District, Hopkinton Reservoir.	3.99
Chicopee, Morton Brook,	4 02
North Adams, Broad Brook,	4.02
Holyoke, Fomer Reservoir,	4.06
Haverhill, Kenoza Lake,	4.07
Manchester, Gravel Pond,	4.07
Northborough, lower reservoir,	4.07
Gloucester, Dike's Brook Reservoir,	4.09
Brockton, Salisbury Brook Reservoir,	4.13
Chicopee, Cooley Brook,	4.13
Peabody, Suntaug Lake,	4.15
Danvers, Middleton Pond,	4.19
Weymouth, Great Pond,	4.19
Easthampton, Bassett Brook,	4.22
Northampton, Middle Reservoir,	4.22
Gloucester, Haskell Brook Reservoir,	4.29
Marlborough, Lake Williams,	4.32
Metropolitan Water District, Framingham Reservoir No. 2.	4.34
Holyoke, Whiting Street Reservoir,	4.35
Lynn, Birch Reservoir,	4.35
Hatfield, Running Gutter Brook Reservoir,	4.36
Gardner, Crystal Lake,	4.41
Randolph, Great Pond,	4.42
Marlborough, Millham Brook Reservoir,	4.43
Lynn, Breed's Reservoir,	4.44
Northampton, West Brook,	4.51
Gloucester, Wallace Reservoir,	4.52
Hadley, Hart's Brook Reservoir,	4.54
Lee, Basin Pond Brook,	4.58
Haverhill, Johnson's Pond,	4.61
Haverhill, Pentucket Lake,	4.66
Adams, Bassett Brook,	4.69
Hudson, Fosgate Brook,	4.69
Longmeadow, Cooley Brook,	4.74
Wayland, Snake Brook Reservoir,	4.78
Wakefield, Crystal Lake,	4.80
Ipswich, Dow's Brook Reservoir,	4.82
Lynn, Walden Reservoir,	4.82
Haverhill, Millvale Reservoir,	4.83
Pittsfield, Ashley Lake,	4.84
West Springfield, Darby Brook Reservoir,	4.89
Cheshire, Kitchen Brook,	5.03
Holyoke, Wright and Ashley Pond,	5.13
Ashfield, Bear Swamp Brook,	5.16
Holyoke, High Service Reservoir,	5.16
Cambridge, Lower Hobbs Brook Reservoir,	5.20
Metropolitan Water District, Lake Cochituate.	5.21
Pittsfield, Mill Brook,	5.21
Greenfield, Glen Brook upper reservoir,	5.28
Great Barrington, East Mountain Reservoir,	5.34
Greenfield, Glen Brook lower reservoir,	5.36
Pittsfield, Ashley Brook,	5.63
Lynn, Hawkes Reservoir,	5.66
Cambridge, Upper Hobbs Brook Reservoir,	5.67
Cheshire, Thunder Brook,	5.69
Haverhill, Lake Saltonstall,	5.69
Cambridge, Stony Brook Reservoir,	5.70
Deerfield, Roaring Brook,	5.79
Salem, Wenham Lake,	5.79
Nantucket, Wannacomet Pond,	6.18
Stockbridge, Lake Averic,	6.19
Peabody, Spring Pond,	6.49
Cambridge, Fresh Pond,	6.61
West Springfield, Bear Hole Brook, filtered,	6.77
Pittsfield, Sacket Brook,	7.04
North Adams, Notch Brook Reservoir,	7.07
Salem, Longham Reservoir,	7.08
Lenox, reservoir,	7.12
Adams, Dry Brook,	8.23
Lynn, Saugus River,	8.24
Rockport, Cape Pond,	9.38
Great Barrington, Green River,	9.41
Pittsfield, Hathaway Brook,	10.23

Ground-water Supplies.

The ground-water supplies in the State are fewer in number than the surface-water sources, and supply in the aggregate a much smaller number of people. Most of the older water works systems which serve the larger communities are supplied from surface sources, while the new supplies are in most cases obtained from the ground. The most common method of obtaining ground water is by means of tubular wells, ranging in depth from 25 feet to 50 feet or more, and more ground-water supplies are obtained in this way than by any other method. Next in number are the supplies obtained from large circular wells, generally from 20 feet to 40 feet deep; then come the filter galleries, so called, which are usually elongated wells 10 feet to 20 feet in depth, located along the shore of a pond or near a stream. The filter galleries are usually rectangular in section, though sometimes of irregular shape, and are in some cases several hundred feet in length. Both the large wells and the filter galleries are in many cases supplemented by tubular wells sunk in their bottoms or in their immediate neighborhood. A few ground-water supplies are obtained directly from natural springs.

Normal ground waters are colorless, contain very little organic matter, and are ordinarily affected by mineral matter in no greater degree than the surface waters of the same region. On account of their attractive appearance and freedom from color, taste or odor, their low temperature in summer, and the greater safety in their use as compared with surface waters, especially in populous regions, ground waters are much the more desirable sources of water supply if they can be obtained. Most of the larger supplies of ground water, such as those at Lowell, Brookline, Newton, Waltham, Woburn, etc., are obtained from the neighborhood of large streams or ponds, and while the water is derived in part from the rain which falls upon and sinks into the ground in the neighborhood of the collecting works, it is derived largely, and in many cases chiefly, from the water which percolates through the ground from the neighboring pond or stream. The surface waters which percolate from ponds or streams through the ground to the various filter galleries or wells are in most cases well purified in their passage through the soil, and become ground waters, differing in no important respect from the waters of wells or springs supplied wholly by the rainfall upon porous soil about them; but some of the ground waters derived from such sources deteriorate in quality after a time on account of a gradual reduction in the efficiency of the purification effected in their passage through the soil. This is especially apt to be the case when the distance from the surface source to the well is quite short. The marked charac-

teristics of such deterioration are an increased quantity of iron and ammonia, and the presence of turbidity, sediment and color, and such deterioration has in some cases become so great as to cause the abandonment of the source of supply. A notable example of such deterioration is the water supply of Middleborough, which was formerly of good quality but has deteriorated so that it is objectionable for many domestic uses.

The averages of the analyses of all the ground-water sources made during the past five years have been calculated in the same way as those of the surface-water sources, and the results are presented in the following table, in which the analyses of the various sources are given alphabetically by towns.

The ground-water sources have been examined generally once in two or three months, but in a few cases as often as once a month.

Some of the sources have been in use for a period of less than five years, and these are mentioned in the notes following the table.

TABLE No. 19. — *Averages of Chemical Analyses from 1905 to 1909 inclusive.*

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.			
Adams, ...	Tubular wells,[1] . .	.01	14.26	.0002	.0007	.11	.0317	.0000	.02	9.8	.0030
Amesbury, . . .	Main Street wells, .	.24	11.76	.0011	.0014	.74	.0314	.0001	.03	5.4	.1612
	Market Street wells, .	.02	26.56	.0034	.0026	1.44	.0077	.0002	.04	14.7	.0100
Attleborough, . .	Old well, ...	.02	4.60	.0006	.0034	.41	.0094	.0000	.05	2.0	.0085
	New well, ...	.02	4.87	.0007	.0038	.40	.0090	.0000	.05	2.0	.0091
Avon, ...	Wells,[1]	.02	4.73	.0006	.0017	.47	.0468	.0000	.01	1.6	.0083
Ayer, ...	Large well, . . .	.01	5.46	.0004	.0020	.57	.0274	.0000	.02	2.2	.0113
	Tubular wells,[1] . .	.00	4.99	.0006	.0008	.17	.0040	.0000	.00	2.0	.0144
Bedford, ...	Large well,[1] . . .	.08	5.71	.0005	.0023	.35	.0020	.0001	–	2.5	.0153
Billerica, ...	Tubular wells, . .	.14	6.65	.0014	.0032	.31	.0049	.0000	.12	2.2	.0428
Braintree, . . .	Filter gallery, . .	.06	5.96	.0024	.0059	1.02	.0415	.0000	.13	1.9	.0102
Bridgewater, . .	Wells, ...	.16	7.92	.0007	.0031	.44	.0081	.0000	.08	3.0	.0876
Brookfield (East), .	Tubular wells,[1] . .	.00	2.74	.0000	.0008	.20	.0042	.0000	–	0.4	.0129
Brookline, . . .	Tubular wells and filter gallery.	.13	9.28	.0044	.0056	.62	.0259	.0001	.14	4.6	.0235
Canton, ...	Springdale well, .	.02	3.99	.0004	.0014	.39	.0082	.0000	.03	1.2	.0161
	Well at Henry's Spring.	.13	4.57	.0007	.0033	.44	.0195	.0000	.12	1.4	.0111
Chelmsford (North),	Tubular wells,[1] . .	.02	3.42	.0032	.0032	.36	.0241	.0001	–	1.1	.0078

[1] See notes.

TABLE No. 19. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Cohasset,	Tubular wells No. 1,	.04	14.03	.0004	.0018	1.81	.0365	.0000	.02	6.0	.0147
	Tubular wells No. 2,	.02	12.10	.0004	.0028	1.62	.0894	.0000	.06	4.9	.0046
	Filter gallery,[1]	.31	11.89	.2430	.0154	1.25	.0199	.0008	.42	5.5	.0422
	Large well,[1]	.27	10.10	.0053	.0097	1.94	.0291	.0002	.34	3.2	.0509
Dedham,	Large well and tubular wells.	.01	10.44	.0009	.0025	.93	.1775	.0000	.04	4.1	.0072
Dracut (Water Supply District).	Tubular wells,[1]	.01	7.42	.0003	.0008	.36	.0280	.0002	.01	3.6	.0096
Dracut (Collinsville),	Tubular wells,	.01	5.72	.0003	.0020	.27	.0208	.0000	.03	2.3	.0090
Easthampton,	Tubular wells,[1]	.00	7.00	.0000	.0009	.13	.0230	.0000	–	4.0	.0062
Easton,	Well,	.01	4.65	.0003	.0018	.57	.0541	.0000	.01	1.6	.0095
Edgartown,	Tubular wells,[1]	.01	3.18	.0001	.0009	.89	.0028	.0000	.01	0.4	.0059
Fairhaven,	Tubular wells,	.39	6.50	.0012	.0081	1.01	.0375	.0001	.47	2.1	.0135
Foxborough,	Tubular wells,	.00	3.75	.0003	.0011	.36	.0284	.0000	.01	0.8	.0072
Framingham,	Filter gallery,	.05	9.31	.0045	.0075	.92	.0241	.0002	.13	4.5	.0166
Franklin,	Tubular wells, old,[1]	.01	7.40	.0003	.0015	.80	.0893	.0002	–	2.5	.0655
	Tubular wells, new,[1]	.01	3.63	.0002	.0013	.24	.0096	.0000	–	0.3	.0093
Grafton,	Filter gallery,	.10	11.23	.0010	.0042	1.43	.2248	.0001	.10	4.2	.0381
Groton,	Large well,	.00	4.75	.0003	.0013	.18	.0062	.0000	.00	2.2	.0055
Hingham,	Wells,	.03	5.50	.0010	.0030	.70	.0131	.0000	.05	1.7	.0093
Hopkinton,	Wells,	.00	12.69	.0003	.0018	1.18	.4117	.0000	.01	5.1	.0100
Hyde Park,	Tubular wells near Neponset River.	.14	13.79	.0190	.0048	2.04	.0688	.0003	.11	5.6	.0830
	Tubular wells near Mother Brook.	.14	8.66	.0006	.0063	.99	.1480	.0000	.22	3.2	.0080
Kingston,	Tubular wells,	.01	4.62	.0004	.0016	.75	.0068	.0000	.01	1.1	.0120
Leicester,	Wells,	.33	6.30	.0009	.0077	.24	.0614	.0000	.43	2.5	.0117
Lowell,	Tubular wells (Boulevard).	.17	5.00	.0088	.0045	.28	.0098	.0001	.11	1.9	.0743
Manchester,	Large well,	.00	11.60	.0004	.0010	1.85	.1507	.0000	.01	4.1	.0094
	Tubular wells,	.00	9.27	.0002	.0012	1.37	.1575	.0000	.02	3.0	.0043
Mansfield,	Large well,	.00	3.31	.0003	.0009	.37	.0298	.0000	.01	0.9	.0059
Marblehead,	Large well No. 2,[1]	.15	18.98	.0209	.0030	2.24	.0064	.0002	.07	7.5	.4615
Marion,	Tubular wells,[1]	.01	4.17	.0002	.0009	.70	.0184	.0000	–	1.0	.0115
Marshfield,	Well,	.00	13.15	.0003	.0013	3.49	.1155	.0000	.02	2.8	.0105
Medfield,	Spring,	.01	4.38	.0055	.0035	.35	.0143	.0003	.11	2.1	.0065
Merrimac,	Tubular wells,	.01	5.24	.0004	.0011	.48	.0425	.0000	.01	1.9	.0109
Methuen,	Tubular wells,	.18	7.29	.0014	.0061	.35	.0143	.0000	.21	3.0	.0366

[1] See notes.

TABLE No. 19. — *Averages of Chemical Analyses, etc.* — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Middleborough,	Well,	.22	6.24	.0029	.0051	.63	.0489	.0001	.14	2.3	.1221
Millbury,	Well,	.02	4.98	.0002	.0019	.34	.0206	.0000	.02	1.9	.0059
Millis,	Spring,	.00	8.18	.0006	.0013	.69	.1625	.0000	.00	3.2	.0025
Monson,	Large well,	.00	3.42	.0003	.0010	.13	.0095	.0000	.00	1.1	.0050
Natick,	Large well,	.00	8.38	.0004	.0017	.56	.0329	.0000	.01	4.3	.0040
Needham,	Well No. 1,	.00	6.41	.0004	.0016	.67	.1088	.0000	.07	2.8	.0039
	Well No. 2,	.00	6.60	.0003	.0016	.71	.1210	.0000	.01	2.3	.0037
	Hicks Spring,	.01	5.01	.0005	.0025	.52	.0917	.0000	.01	1.6	.0046
Newburyport,	Wells and springs,	.12	12.50	.0008	.0033	2.45	.0229	.0000	.05	4.4	.0889
Newton,	Tubular wells and filter gallery.	.06	6.57	.0007	.0040	.44	.0286	.0000	.13	2.8	.0075
North Attleborough,	Old well,	.01	6.59	.0004	.0016	.62	.0462	.0000	.01	2.8	.0129
	New well,	.00	4.44	.0003	.0014	.33	.0048	.0000	.01	1.9	.0095
Oak Bluffs,	Springs,	.02	4.07	.0006	.0012	1.01	.0120	.0000	.00	0.6	.0146
Oxford,	Tubular wells,[1]	.00	4.32	.0002	.0008	.28	.0352	.0000	–	1.6	.0040
Palmer (Bondsville),	Tubular wells,[1]	.00	5.00	.0006	.0012	.17	.0186	.0000	–	1.8	.0052
Pepperell,	Tubular wells,[1]	.00	3.47	.0000	.0005	.16	.0013	.0000	–	1.3	.0023
Provincetown,	Old wells,	–	11.45	.0171	.0184	2.41	.0031	.0001	.80	3.6	.7842
	Tubular wells in Truro.[1]	.01	6.04	.0001	.0006	2.13	.0078	.0000	–	1.2	.0048
Reading,	Filter gallery,[1]	.52	8.83	.0114	.0107	.98	.0036	.0000	.50	2.9	.2574
	Filtered water,[1]	.16	13.30	.0081	.0075	.98	.0034	.0003	.24	6.8	.0383
Scituate,	Tubular wells,	.01	16.12	.0003	.0012	3.52	.1941	.0000	.02	4.9	.0087
Sharon,	Well,	.00	10.88	.0005	.0014	1.26	.2415	.0000	.01	3.9	.0058
Sheffield,	Spring,	.08	3.91	.0007	.0059	.09	.0026	.0000	.27	1.9	.0084
Shirley,	Well,	.00	2.55	.0004	.0007	.15	.0037	.0000	.00	0.3	.0125
Tisbury,	Well,	.00	4.35	.0002	.0013	1.03	.0031	.0000	.00	0.5	.0061
Uxbridge,	Tubular wells,[1]	.01	4.70	.0006	.0011	.48	.0899	.0000	.01	1.5	.0091
Walpole,	Tubular wells,	.00	4.34	.0003	.0009	.38	.0270	.0000	.00	1.4	.0051
Waltham,	Old well,	.11	7.93	.0032	.0033	.69	.0269	.0000	.08	3.4	.0478
	New well,[1]	.02	7.89	.0008	.0026	.58	.0173	.0000	–	3.8	.0096
Ware,	Wells,	.00	7.72	.0003	.0011	.57	.2363	.0000	.01	2.7	.0059
Wareham (Fire District).	Tubular wells,[1]	.02	3.49	.0002	.0009	.61	.0028	.0000	–	0.9	.0070
Webster,	Wells,	.03	4.06	.0008	.0030	.27	.0167	.0000	.05	1.3	.0114
Wellesley,	Tubular wells,	.00	8.62	.0004	.0014	.84	.1174	.0000	.02	3.6	.0059

[1] See notes.

TABLE No. 19. — *Averages of Chemical Analyses, etc.* — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Wellesley — *Con.*	Well at Williams Spring.	.00	11.59	.0013	.0018	1.18	.3995	.0000	.03	4.2	.0100
Westborough,	Filter basin,[1]	.07	3.16	.0022	.0118	.23	.0011	.0001	.17	1.0	–
Westford,	Tubular wells,[1]	.01	3.67	.0002	.0009	.19	.0050	.0000	–	1.0	.0047
Weston,	Well,	.23	8.22	.0013	.0090	.48	.0268	.0000	.41	3.4	.0078
Winchendon,	Well,	.11	3.28	.0017	.0026	.12	.0033	.0000	.04	0.7	.0777
Woburn,	Filter gallery and wells.[1]	.01	10.33	.0071	.0037	1.22	.0150	.0000	.07	5.0	.0034
Wrentham,	Tubular wells,[1]	.00	2.93	.0003	.0010	.28	.0033	.0000	–	0.8	.0041

[1] See notes.

NOTES.

Adams, Tubular Wells. — The water of these wells is used only in the drier portions of the year, and is pumped into Bassett Brook and supplied thence to the town.

Avon, Wells. — A large well was the sole source of supply until 1908–09, when two deep tubular wells were driven.

Ayer, Tubular Wells. — Completed and first used in 1906.

Bedford, Large Well. — Completed and first used in 1909.

Brookfield (East), Tubular Wells. — Completed and first used in 1909.

Chelmsford (North), Tubular Wells. — Completed and first used in 1907.

Cohasset, Filter Gallery. — This gallery is situated on the shore of Lily Pond, and is used as an auxiliary source of supply in the drier portions of the year.

Cohasset, Large Well. — Completed in 1909 and not yet used.

Dracut (Water Supply District), Tubular Wells. — Completed and first used in 1906.

Easthampton, Tubular Wells. — Completed and first used in 1909.

Edgartown, Tubular Wells. — Completed and first used in 1906.

Franklin, Tubular Wells (old). — Completed and first used in 1907.

Franklin, Tubular Wells (new). — Completed near the end of the year 1909.

Marblehead, Large Well No. 2. — The water of this well contains an excessive quantity of iron, and in 1909 artificial sand filters were constructed for the removal of this iron.

Marion, Tubular Wells. — Completed and first used in 1908.

Oxford, Tubular Wells. — Completed and first used in 1906.

Palmer (Bondsville), Tubular Wells. — Completed and first used in 1908.

Pepperell, Tubular Wells. — Completed and first used in 1909.

Provincetown, Tubular Wells in Truro. — Completed and first used in 1908.

Reading, Filter Gallery. — The water from this gallery contains an excessive quantity of iron, and is treated with lime and alum and subsequently filtered through a mechanical filter. The filtered water represents the water after treatment and filtration.

Uxbridge, Tubular Wells. — Completed and first used in 1906.

Waltham, New Well. — Completed and first used in 1908.

Wareham (Fire District), Tubular Wells. — Completed and first used in 1908.

Westborough, Filter Basin. — The water supply of Westborough is taken from a large open basin fed by water which filters through the ground from Sandra Pond and by ground water from adjacent territory.

Westford, Tubular Wells. — Completed and first used in 1908.

Woburn, Filter Gallery and Wells. — The filter gallery has been in constant use since 1873, but the tubular wells were not completed until 1909.

Wrentham, Tubular Wells. — Completed and first used in 1908.

The most important consideration in comparing the quality of various ground waters is their relative freedom from sewage pollution. In the case of surface waters it is usually a simple matter to determine, with reasonable accuracy, the population within the watershed of a source of supply which may affect the quality of its water, but in the case of a ground-water supply the area from which water percolates to the source is often indefinite and rarely determinable with accuracy, and some further means of determining the degree to which it is affected by population in the region about it is usually necessary.

Ground waters drawn from populous regions show very clearly upon chemical analysis the effect of the pollution of the water by sewage or other wastes of human life. Chlorine, though a normal constituent of the waters of all parts of the State, is a characteristic ingredient of sewage, and the normal quantity having been determined, the excess due to sewage or the wastes of human life and industry can be ascertained. The normal chlorine of the waters of the State is greatest near the sea, and decreases as the distance from the sea increases. It changes very rapidly within short distances near the seashore, and in consequence of a lack of sufficient information in some cases the normal at such places is still uncertain, but very few of the ground waters of the State are affected by this uncertainty.

The ground waters of the State have been classified in accordance with the determination of the excess of chlorine above the normal, and the results are presented in the following table, which has been divided into three groups.

The first group includes normal waters and those in which the excess of chlorine above the normal is less than 0.10 of a part in 100,000. The second group includes those waters in which the excess of chlorine above the normal is between 0.11 and 0.30 of a part in 100,000. The third group includes those waters in which the excess of chlorine above the normal is more than 0.30 of a part in 100,000.

Table No. 20. — *Ground-water Sources arranged in Groups according to the Excess of Chlorine above the Normal.*

Group 1. — Normal Ground Waters and those in which the Excess of Chlorine is less than .10 of a Part in 100,000.

City or Town.	Source.	City or Town.	Source.
Adams, . . .	Tubular wells.	Marshfield, . .	Well.
Ayer, . . .	Tubular wells.	Medfield, . . .	Spring.
Bedford, . . .	Large well.	Merrimac, . . .	Tubular wells.
Billerica, . . .	Tubular wells.	Monson, . . .	Large well.
Bridgewater, . .	Wells.	Newton, . . .	Tubular wells and filter gallery.
Brookfield (East), .	Tubular wells.	North Attleborough,	New well.
Cohasset, . . .	Filter gallery.	Oak Bluffs, . .	Springs.
	Large well.	Palmer (Bondsville),	Tubular wells.
Dracut (Collinsville),	Tubular wells.	Pepperell, . . .	Tubular wells.
Easthampton, . .	Tubular wells.	Provincetown, . .	Tubular wells in Truro.
Edgartown, . .	Tubular wells.		Old wells.
Franklin, . . .	Tubular wells, new.	Sheffield, . . .	Spring.
Groton, . . .	Large well.	Shirley, . . .	Well.
Hingham, . . .	Wells.	Tisbury, . . .	Well.
Kingston, . . .	Tubular wells.	Wareham (Fire District).	Tubular wells.
Leicester, . . .	Wells.	Webster, . . .	Wells.
Lowell, . . .	Tubular wells (Boulevard).	Westborough, . .	Filter basin.
Mansfield, . . .	Large well.	Westford, . . .	Tubular wells.
Marblehead, . .	Large well No. 2.	Winchendon, . .	Well.
Marion, . . .	Tubular wells.	Wrentham, . .	Tubular wells.

Group 2. — Ground Waters in which the Excess of Chlorine is between .11 and .30 of a Part in 100,000.

City or Town.	Source.	City or Town.	Source.
Attleborough, . .	Old well.	Foxborough, . .	Tubular wells.
	New well.	Methuen, . . .	Tubular wells.
Avon, . . .	Wells.	Middleborough, .	Well.
Brookline, . .	Tubular wells and filter gallery.	Millbury, . . .	Well.
Canton, . . .	Springdale well.	Needham, . .	Hicks Spring.
	Well at Henry's Spring.	Newburyport, . .	Wells and springs.
Chelmsford (North),	Tubular wells.	Oxford, . . .	Tubular wells.
Dracut (Water Supply District).	Tubular wells.	Uxbridge, . . .	Tubular wells.
Easton, . . .	Well.	Walpole, . . .	Tubular wells.
Fairhaven, . .	Tubular wells.	Weston, . . .	Well.

TABLE No. 20. — *Ground-water Sources arranged in Groups, etc.* — Concluded.

Group 3. — Ground Waters in which the Excess of Chlorine is more than .30 of a Part in 100,000.

City or Town.	Source.	City or Town.	Source.
Amesbury, . .	Main Street wells.	Millis, . . .	Spring.
	Market Street wells.	Natick, . . .	Large well.
Ayer, . . .	Large well.	Needham, . .	Well No. 1.
Braintree, . . .	Filter gallery.		Well No. 2.
Cohasset, . . .	Tubular wells No. 1.	North Attleborough,.	Old well.
	Tubular wells No. 2.	Reading, . . .	Filter gallery.
Dedham, . . .	Large well and tubular wells.	Scituate, . . .	Tubular wells.
Framingham, . .	Filter gallery.	Sharon, . . .	Well.
Franklin, . . .	Tubular wells, old.	Waltham, . . .	Old well.
Grafton, . . .	Filter gallery.		New well.
Hopkinton, . .	Wells.	Ware, . . .	Wells.
Hyde Park, . .	Tubular wells near Neponset River.	Wellesley, . . .	Tubular wells.
	Tubular wells near Mother Brook.		Well at Williams Spring.
Manchester, . .	Large well and tubular wells.	Woburn, . . .	Filter gallery and wells.

NITRATES IN GROUND WATERS.

The quantity of nitrates present in ground waters is in some degree a measure, though a somewhat less definite and reliable one in this State than the excess of chlorine, of the extent to which these waters have been exposed to pollution by sewage before entering the collecting works from which the water is drawn. Ground waters from an uninhabited watershed in which the land has not been cultivated or polluted in any way by animal matter are very low in nitrates, and often contain none at all. The use of lands for pasturage tends to increase slightly the quantity of nitrates present in the ground waters of the region so used. Ground waters from lands under cultivation, even though free from human habitation, contain a noticeably larger quantity of nitrates than in the cases where the land has been unused or used only for pasturage. In thickly settled regions the ground waters are nearly always very high in nitrates, formed from the ammonia of house drainage and other animal matter. This determination is, therefore, of great value as an indication of previous pollution in ground waters, and if taken in connection with the excess of chlorine is a very important index of the amount of this previous pollution.

Table No. 21. — *Nitrates in Ground Waters.*

[Parts in 100,000.]

Westborough, filter basin,	.0011	Cohasset, filter gallery,	.0199
Pepperell, tubular wells,	.0013	Millbury, well,	.0206
Bedford, large well,	.0020	Dracut (Collinsville), tubular wells,	.0208
Sheffield, spring,	.0026	Newburyport, wells and springs,	.0229
Edgartown, tubular wells,	.0028	Easthampton, tubular wells,	.0230
Wareham (Fire District), tubular wells,	.0028	Chelmsford (North), tubular wells,	.0241
Provincetown, old wells,	.0031	Framingham, filter gallery,	.0241
Tisbury, well,	.0031	Brookline, tubular wells and filter gallery,	.0259
Winchendon, well,	.0033	Weston, well,	.0268
Wrentham, tubular wells,	.0033	Waltham, old well,	.0269
Reading, filtered water,	.0034	Walpole, tubular wells,	.0270
Reading, filter gallery,	.0036	Ayer, large well,	.0274
Shirley, well,	.0037	Dracut (Water Supply District), tubular wells.	.0280
Ayer, tubular wells,	.0040	Foxborough, tubular wells,	.0284
Brookfield (East), tubular wells,	.0042	Newton, tubular wells and filter gallery,	.0286
North Attleborough, new well,	.0048	Cohasset, large well,	.0291
Billerica, tubular wells,	.0049	Mansfield, large well,	.0298
Westford, tubular wells,	.0050	Amesbury, Main Street wells,	.0314
Groton, large well,	.0062	Adams, tubular wells,	.0317
Marblehead, large well No. 2,	.0064	Natick, large well,	.0329
Kingston, tubular wells,	.0068	Oxford, tubular wells,	.0352
Amesbury, Market Street wells,	.0077	Cohasset, tubular wells No. 1,	.0365
Provincetown, tubular wells in Truro,	.0078	Fairhaven, tubular wells,	.0375
Bridgewater, wells,	.0081	Braintree, filter gallery,	.0415
Canton, Springdale well,	.0082	Merrimac, tubular wells,	.0425
Attleborough, new well,	.0090	North Attleborough, old well,	.0462
Attleborough, old well,	.0094	Avon, wells,	.0468
Monson, large well,	.0095	Middleborough, well,	.0489
Franklin, tubular wells, new,	.0096	Easton, well,	.0541
Lowell, tubular wells (Boulevard),	.0098	Leicester, wells,	.0614
Oak Bluffs, springs,	.0120	Hyde Park, tubular wells near Neponset River.	.0688
Hingham, wells,	.0131	Franklin, tubular wells, old,	.0893
Medfield, spring,	.0143	Cohasset, tubular wells No. 2,	.0894
Methuen, tubular wells,	.0143	Uxbridge, tubular wells,	.0899
Woburn, filter gallery and wells,	.0150	Needham, Hicks Spring,	.0917
Webster, wells,	.0167	Needham, well No. 1,	.1088
Waltham, new well,	.0173	Marshfield, well,	.1155
Marion, tubular wells,	.0184	Wellesley, tubular wells,	.1174
Palmer (Bondsville), tubular wells,	.0186	Needham, well No. 2,	.1210
Canton, well at Henry's Spring,	.0195	Hyde Park, tubular wells near Mother Brook,	.1480

TABLE No. 21. — *Nitrates in Ground Waters* — Concluded.

[Parts in 100,000.]

Manchester, large well,	.1507	Grafton, filter gallery,	.2248
Manchester, tubular wells,	.1575	Ware, wells,	.2363
Millis, spring,	.1625	Sharon, well,	.2415
Dedham, large well and tubular wells,	.1775	Wellesley, well at Williams Spring,	.3995
Scituate, tubular wells,	.1941	Hopkinton, wells,	.4117

AMMONIA IN GROUND WATERS.

Nearly all ground waters, even those of the best springs and wells in unpopulated regions, contain very small quantities of free and albuminoid ammonia, though at times these substances are wholly absent. The determinations of chlorine and nitrates already given are the important means of showing, by chemical analysis, the comparative degree to which ground waters are affected by pollution; the determinations of the free and albuminoid ammonias in ground waters are indices of the extent to which a polluted water has been purified and freed from organic matter in its passage through the ground. Imperfectly purified waters, or waters which enter wells or springs while still undergoing the process of purification, usually contain considerable quantities of ammonia, both free and albuminoid, and the quantity of free ammonia especially is sometimes very large. The ammonia in a ground water may be derived from sewage or from decaying vegetable or organic matter unaffected by sewage. The ammonias present in sewage are very high, but in a thoroughly purified sewage effluent they may be no greater than in a good spring or well water.

The water of an unpolluted pond or reservoir containing a large quantity of ammonia, on account of the presence of organic matter of a vegetable origin, may, after passing through the ground to a filter gallery or well, become nearly or quite as free from ammonia as the natural ground water of the region. Some ground waters are affected by the presence of organic matter in the ground from which they are drawn, those from beneath springs or deep layers of peaty soil usually containing very large quantities of ammonia and iron, evidently derived from the organic matter in the ground in which the collecting works are located.

Some of the filter galleries and wells located near streams and ponds have now been in use as public water supplies for many years. In some cases the quality of the water shows no material change from the time the first examination was made, but in other cases the quantity of free and albuminoid ammonia has increased, indicating that a part at least

of the water entering these sources is imperfectly purified. In imperfectly purified waters the increase in ammonias is usually accompanied by an increase in iron and in nitrites, and later by the presence of turbidity, sediment and color. The average quantity of albuminoid ammonia and free ammonia in the various ground-water supplies in the State during the past five years is given in the following tables, Nos. 22 and 23: —

TABLE No. 22. — *Albuminoid Ammonia in Ground Waters.*

[Parts in 100,000.]

Pepperell, tubular wells,	.0005	North Attleborough, new well,	.0014
Provincetown, tubular wells in Truro,	.0006	Sharon, well,	.0014
Adams, tubular wells,	.0007	Wellesley, tubular wells,	.0014
Shirley, well,	.0007	Franklin, tubular wells, old,	.0015
Ayer, tubular wells,	.0008	Kingston, tubular wells,	.0016
Brookfield (East), tubular wells,	.0008	Needham, well No. 1,	.0016
Dracut (Water Supply District), tubular wells.	.0008	Needham, well No. 2,	.0016
Oxford, tubular wells,	.0008	North Attleborough, old well,	.0016
Easthampton, tubular wells,	.0009	Avon, wells,	.0017
Edgartown, tubular wells,	.0009	Natick, large well,	.0017
Mansfield, large well,	.0009	Cohasset, tubular wells No. 1,	.0018
Marion, tubular wells,	.0009	Easton, well,	.0018
Walpole, tubular wells,	.0009	Hopkinton, wells,	.0018
Wareham (Fire District), tubular wells,	.0009	Wellesley, well at Williams Spring,	.0018
Westford, tubular wells,	.0009	Millbury, well,	.0019
Manchester, large well,	.0010	Ayer, large well,	.0020
Monson, large well,	.0010	Dracut (Collinsville), tubular wells,	.0020
Wrentham, tubular wells,	.0010	Bedford, large well,	.0023
Foxborough, tubular wells,	.0011	Dedham, large well and tubular wells,	.0025
Merrimac, tubular wells,	.0011	Needham, Hicks Spring,	.0025
Uxbridge, tubular wells,	.0011	Amesbury, Market Street wells,	.0026
Ware, wells,	.0011	Waltham, new well,	.0026
Manchester, tubular wells,	.0012	Winchendon, well,	.0026
Oak Bluffs, springs,	.0012	Cohasset, tubular wells No. 2,	.0028
Palmer (Bondsville), tubular wells,	.0012	Hingham, wells,	.0030
Scituate, tubular wells,	.0012	Marblehead, large well No. 2,	.0030
Franklin, tubular wells, new,	.0013	Webster, wells,	.0030
Groton, large well,	.0013	Bridgewater, wells,	.0031
Marshfield, well,	.0013	Billerica, tubular wells,	.0032
Millis, spring,	.0013	Chelmsford (North), tubular wells,	.0032
Tisbury, well,	.0013	Canton, well at Henry's Spring,	.0033
Amesbury, Main Street wells,	.0014	Newburyport, wells and springs,	.0033
Canton, Sprindgale well,	.0014	Waltham, old well,	.0033

TABLE No. 22. — *Albuminoid Ammonia in Ground Waters* — Concluded.

[Parts in 100,000.]

Attleborough, old well,	.0034	Methuen, tubular wells,	.0061
Medfield, spring,	.0035	Hyde Park, tubular wells near Mother Brook.	.0063
Woburn, filter gallery and wells,	.0037	Framingham, filter gallery,	.0075
Attleborough, new well,	.0038	Reading, filtered water,	.0075
Newton, tubular wells and filter gallery,	.0040	Leicester, wells,	.0077
Grafton, filter gallery,	.0042	Fairhaven, tubular wells,	.0081
Lowell, tubular wells (Boulevard),	.0045	Weston, well,	.0090
Hyde Park, tubular wells near Neponset River.	.0048	Cohasset, large well,	.0097
Middleborough, well,	.0051	Reading, filter gallery,	.0107
Brookline, tubular wells and filter gallery,	.0056	Westborough, filter basin,	.0118
Braintree, filter gallery,	.0059	Cohasset, filter gallery,	.0154
Sheffield, spring,	.0059	Provincetown, old wells,	.0184

TABLE No. 23. — *Free Ammonia in Ground Waters.*

[Parts in 100,000.]

Brookfield (East), tubular wells,	.0000	Needham, well No. 2,	.0003
Easthampton, tubular wells,	.0000	North Attleborough, new well,	.0003
Pepperell, tubular wells,	.0000	Scituate, tubular wells,	.0003
Edgartown, tubular wells,	.0001	Walpole, tubular wells,	.0003
Provincetown, tubular wells in Truro,	.0001	Ware, wells,	.0003
Adams, tubular wells,	.0002	Wrentham, tubular wells,	.0003
Franklin, tubular wells, new,	.0002	Ayer, large well,	.0004
Manchester, tubular wells,	.0002	Canton, Springdale well,	.0004
Marion, tubular wells,	.0002	Cohasset, tubular wells No. 1,	.0004
Millbury, well,	.0002	Cohasset, tubular wells No. 2,	.0004
Oxford, tubular wells,	.0002	Kingston, tubular wells,	.0004
Tisbury, well,	.0002	Manchester, large well,	.0004
Wareham (Fire District), tubular wells,	.0002	Merrimac, tubular wells,	.0004
Westford, tubular wells,	.0002	Natick, large well,	.0004
Dracut (Collinsville), tubular wells,	.0003	Needham, well No. 1,	.0004
Dracut (Water Supply District), tubular wells.	.0003	North Attleborough, old well,	.0004
Easton, well,	.0003	Shirley, well,	.0004
Foxborough, tubular wells,	.0003	Wellesley, tubular wells,	.0004
Franklin, tubular wells, old,	.0003	Bedford, large well,	.0005
Groton, large well,	.0003	Needham, Hicks Spring,	.0005
Hopkinton, wells,	.0003	Sharon, well,	.0005
Mansfield, large well,	.0003	Attleborough, old well,	.0006
Marshfield, well,	.0003	Avon, wells,	.0006
Monson, large well,	.0003	Ayer, tubular wells,	.0006

Table No. 23. — *Free Ammonia in Ground Waters.* — Concluded.

[Parts in 100,000.]

Hyde Park, tubular wells near MotherBrook,	.0006
Millis, spring,	.0006
Oak Bluffs, springs,	.0006
Palmer (Bondsville), tubular wells,	.0006
Uxbridge, tubular wells,	.0006
Attleborough, new well,	.0007
Bridgewater, wells,	.0007
Canton, Wells at Henry's Spring,	.0007
Newton, tubular wells and filter gallery,	.0007
Sheffield, spring,	.0007
Newburyport, wells and springs,	.0008
Waltham, new well,	.0008
Webster, wells,	.0008
Dedham, large well and tubular wells,	.0009
Leicester, wells,	.0009
Grafton, filter gallery,	.0010
Hingham, wells,	.0010
Amesbury, Main Street wells,	.0011
Fairhaven, tubular wells,	.0012
Wellesley, well at Williams Spring,	.0013
Weston, well,	.0013
Billerica, tubular wells,	.0014
Methuen, tubular wells,	.0014
Winchendon, well,	.0017
Westborough, filter basin,	.0022
Braintree, filter gallery,	.0024
Middleborough, well,	.0029
Chelmsford (North), tubular wells,	.0032
Waltham, old well,	.0032
Amesbury, Market Street wells,	.0034
Brookline, tubular wells and filter gallery,	.0044
Framingham, filter gallery,	.0045
Cohasset, large well,	.0053
Medfield, spring,	.0055
Woburn, filter gallery and wells,	.0071
Reading, filtered water,	.0081
Lowell, tubular wells (Boulevard),	0088
Reading, filter gallery,	.0114
Provincetown, old wells,	.0171
Hyde Park, tubular wells near Neponset River.	.0190
Marblehead, large well No. 2,	.0209
Cohasset, filter gallery,	.2430

Iron in Ground Waters.

Many ground waters contain iron in sufficient amount to produce a rusty precipitate when the water is exposed to air, and the iron becomes oxidized. Iron is frequently present in water which has passed through peat or other soil containing a large quantity of organic matter, and which has not been subsequently purified in its passage through sand or gravel to the collecting works. When a ground water contains .05 of a part of metallic iron in 100,000 in solution it will generally precipitate on standing, giving the water first a milky turbidity and subsequently a rusty sediment. In some ground waters this precipitation takes place rapidly, and the water subsequently becomes again clear and colorless, while in other cases the iron precipitates very slowly and can only be removed from the water within a reasonable time by some less simple method. The quantity of iron varies greatly at different seasons of the year in most of those waters in which it is present in considerable quantity, being insignificant in some seasons while in others it is present in sufficient quantity to cause serious trouble. The determination of iron

is of great importance in the case of new ground-water supplies, for a constant increase on continued pumping, even though the amount may be very small at first, points to a time when the amount of iron will be excessive.

From the following table, which shows the average quantity of iron present in the various ground waters of the State during the past five years, it will be seen that in over 50 per cent. the quantity of iron present is less than .0100 of a part in 100,000 and in only 13 is it in excess of .0500 of a part in 100,000. Of these latter, the water of the large well at Cohasset has never been used, the use of the old wells at Provincetown and Franklin has been discontinued, and filters have been installed for removing the iron from the water of the filter gallery at Reading and the well at Marblehead.

Table No. 24. — *Iron in Ground Waters.*

[Parts in 100,000.]

Pepperell, tubular wells,	.0023	Medfield, spring,	.0065
Millis, spring,	.0025	Wareham (Fire District), tubular wells,	.0070
Adams, tubular wells,	.0030	Dedham, large well and tubular wells,	.0072
Woburn, filter gallery and wells,	.0034	Foxborough, tubular wells,	.0072
Needham, well No. 2,	.0037	Newton, tubular wells and filter gallery,	.0075
Needham, well No. 1,	.0039	Chelmsford (North), tubular wells,	.0078
Natick, large well,	.0040	Weston, well,	.0078
Oxford, tubular wells,	.0040	Hyde Park, tubular wells near Mother Brook,	.0080
Wrentham, tubular wells,	.0041	Avon, wells,	.0083
Manchester, tubular wells,	.0043	Sheffield, spring,	.0084
Cohasset, tubular wells No. 2,	.0046	Attleborough, old well,	.0085
Needham, Hicks Spring,	.0046	Scituate, tubular wells,	.0087
Westford, tubular wells,	.0047	Dracut (Collinsville), tubular wells,	.0090
Provincetown, tubular wells in Truro,	.0048	Attleborough, new well,	.0091
Monson, large well,	.0050	Uxbridge, tubular wells,	.0091
Walpole, tubular wells,	.0051	Franklin, tubular wells, new,	.0093
Palmer (Bondsville), tubular wells,	.0052	Hingham, wells,	.0093
Groton, large well,	.0055	Manchester, large well,	.0094
Sharon, well,	.0058	Easton, well,	.0095
Edgartown, tubular wells,	.0059	North Attleborough, new well,	.0095
Mansfield, large well,	.0059	Dracut (Water Supply District), tubular wells.	.0096
Millbury, well,	.0059	Waltham, new well,	.0096
Ware, wells,	.0059	Amesbury, Market Street wells,	.0100
Wellesley, tubular wells,	.0059	Hopkinton, wells,	.0100
Tisbury, well,	.0061	Wellesley, well at Williams Spring,	.0100
Easthampton, tubular wells,	.0062	Braintree, filter gallery,	.0102

TABLE No. 24. — *Iron in Ground Waters* — Concluded.

[Parts in 100,000.]

Marshfield, well,	.0105	Methuen, tubular wells,	.0366
Merrimac, tubular wells,	.0109	Grafton, filter gallery,	.0381
Canton, well at Henry's Spring,	.0111	Reading, filtered water,	.0383
Ayer, large well,	.0113	Cohasset, filter gallery,	.0422
Webster, wells,	.0114	Billerica, tubular wells,	.0428
Marion, tubular wells,	.0115	Waltham, old well,	.0478
Leicester, wells,	.0117	Cohasset, large well,	.0509
Kingston, tubular wells,	.0120	Franklin, tubular wells, old,	.0655
Shirley, well,	.0125	Lowell, tubular wells (Boulevard),	.0743
Brookfield (East), tubular wells,	.0129	Winchendon, well,	.0777
North Attleborough, old well,	.0129	Hyde Park, tubular wells near Neponset River.	.0830
Fairhaven, tubular wells,	.0135	Bridgewater, wells,	.0876
Ayer, tubular wells,	.0144	Newburyport, wells and springs,	.0889
Oak Bluffs, springs,	.0146	Middleborough, well,	.1221
Cohasset, tubular wells No. 1,	.0147	Amesbury, Main Street wells,	.1612
Bedford, large well,	.0153	Reading, filter gallery,	.2574
Canton, Springdale well,	.0161	Marblehead, large well No. 2,	.4615
Framingham, filter gallery,	.0166	Provincetown, old wells,	.7842
Brookline, tubular wells and filter gallery,	.0235		

HARDNESS OF GROUND WATERS.

The remarks concerning the hardness of surface waters apply also to ground waters. Normal ground waters in most parts of the State are soft, although apparently somewhat harder than normal surface waters of the same region. The harder waters are found in the limestone regions, located chiefly in the western part of the State and in thickly settled localities where the ground water is affected by sewage and other wastes. About half the ground waters of the State have a hardness of less than 2.5 parts in 100,000, and only 10 have a hardness of more than 5.0 parts in 100,000. The hardness of the filtered water supplied to the town of Reading is greatly increased by the lime and alum used in the process of purifying this water, which contains an excessive quantity of iron. The average hardness of the various ground-water supplies of the State during the past five years is given in the following table: —

TABLE No. 25. — *Hardness of Ground Waters.*

[Parts in 100,000.]

Franklin, tubular wells, new,	0.3	Medfield, spring,	2.1
Shirley, well,	0.3	Ayer, large well,	2.2
Brookfield (East), tubular wells,	0.4	Billerica, tubular wells,	2.2
Edgartown, tubular wells,	0.4	Groton, large well,	2.2
Tisbury, well,	0.5	Dracut (Collinsville), tubular wells,	2.3
Oak Bluffs, springs,	0.6	Middleborough, well,	2.3
Winchendon, well,	0.7	Needham, well No. 2,	2.3
Foxborough, tubular wells,	0.8	Bedford, large well,	2.5
Wrentham, tubular wells,	0.8	Franklin, tubular wells, old,	2.5
Mansfield, large well,	0.9	Leicester, wells,	2.5
Wareham (Fire District), tubular wells,	0.9	Ware, wells,	2.7
Marion, tubular wells,	1.0	Marshfield, well,	2.8
Westborough, filter basin,	1.0	Needham, well No. 1,	2.8
Westford, tubular wells,	1.0	Newton, tubular wells and filter gallery,	2.8
Chelmsford (North), tubular wells,	1.1	North Attleborough, old well,	2.8
Kingston, tubular wells,	1.1	Reading, filter gallery,	2.9
Monson, large well,	1.1	Bridgewater, wells,	3.0
Canton, Springdale well,	1.2	Manchester, tubular wells,	3.0
Provincetown, tubular wells in Truro,	1.2	Methuen, tubular wells,	3.0
Pepperell, tubular wells,	1.3	Cohasset, large well,	3.2
Webster, wells,	1.3	Hyde Park, tubular wells near Mother Brook,	3.2
Canton, well at Henry's Spring,	1.4	Millis, spring,	3.2
Walpole, tubular wells,	1.4	Waltham, old well,	3.4
Uxbridge, tubular wells,	1.5	Weston, well,	3.4
Avon, wells,	1.6	Dracut (Water Supply District), tubular wells.	3.6
Easton, well,	1.6	Provincetown, old wells,	3.6
Needham, Hicks Spring,	1.6	Wellesley, tubular wells,	3.6
Oxford, tubular wells,	1.6	Waltham, new well,	3.8
Hingham, wells,	1.7	Sharon, well,	3.9
Palmer (Bondsville), tubular wells,	1.8	Easthampton, tubular wells,	4.0
Braintree, filter gallery,	1.9	Dedham, large well and tubular wells,	4.1
Lowell, tubular wells (Boulevard),	1.9	Manchester, large well,	4.1
Merrimac, tubular wells,	1.9	Grafton, filter gallery,	4.2
Millbury, well,	1.9	Wellesley, well at Williams Spring,	4.2
North Attleborough, new well,	1.9	Natick, large well,	4.3
Sheffield, spring,	1.9	Newburyport, wells and springs,	4.4
Attleborough, old well,	2.0	Framingham, filter gallery,	4.5
Attleborough, new well,	2.0	Brookline, tubular wells and filter gallery,	4.6
Ayer, tubular wells,	2.0	Cohasset, tubular wells No. 2,	4.9
Fairhaven, tubular wells,	2.1	Scituate, tubular wells,	4.9

Table No. 25. — *Hardness of Ground Waters* — Concluded.

[Parts in 100,000.]

Woburn, filter gallery and wells,	5.0	Cohasset, tubular wells No. 1,	6.0
Hopkinton, wells,	5.1	Reading, filtered water,	6.8
Amesbury, Main Street wells,	5.4	Marblehead, large well No. 2,	7.5
Cohasset, filter gallery,	5.5	Adams, tubular wells,	9.8
Hyde Park, tubular wells near Neponset River,	5.6	Amesbury, Market Street wells,	14.7

Residue on Evaporation in Ground Waters.

The remarks concerning the presence of dissolved mineral matter in surface waters apply also to ground waters. The highest total residue in unpolluted ground waters is found in the limestone regions and in wells near the sea, and the high total residue in other places is usually an indication of the previous pollution of the water by sewage. About 50 per cent. of the ground waters of the State have a total residue of less than 6.5 parts in 100,000, and 75 per cent. of the waters have a total residue of less than 10 parts in 100,000. The total residue in the various ground-water supplies in the State is shown in the following table: —

Table No. 26. — *Residue on Evaporation in Ground Waters.*

[Parts in 100,000.]

Shirley, well,	2.55	Walpole, tubular wells,	4.34
Brookfield (East), tubular wells,	2.74	Tisbury, well,	4.35
Wrentham, tubular wells,	2.93	Medfield, spring,	4.38
Westborough, filter basin,	3.16	North Attleborough, new well,	4.44
Edgartown, tubular wells,	3.18	Canton, well at Henry's Spring,	4.57
Winchendon, well,	3.28	Attleborough, old well,	4.60
Mansfield, large well,	3.31	Kingston, tubular wells,	4.62
Chelmsford (North), tubular wells,	3.42	Easton, well,	4.65
Monson, large well,	3.42	Uxbridge, tubular wells,	4.70
Pepperell, tubular wells,	3.47	Avon, wells,	4.73
Wareham (Fire District), tubular wells,	3.49	Groton, large well,	4.75
Franklin, tubular wells, new,	3.63	Attleborough, new well,	4.87
Westford, tubular wells,	3.67	Millbury, well,	4.98
Foxborough, tubular wells,	3.75	Ayer, tubular wells,	4.99
Sheffield, spring,	3.91	Lowell, tubular wells (Boulevard),	5.00
Canton, Springdale well,	3.99	Palmer (Bondsville), tubular wells,	5.00
Webster, wells,	4.06	Needham, Hicks Spring,	5.01
Oak Bluffs, springs,	4.07	Merrimac, tubular wells,	5.24
Marion, tubular wells,	4.17	Ayer, large well,	5.46
Oxford, tubular wells,	4.32	Hingham, wells,	5.50

TABLE No. 26. — *Residue on Evaporation in Ground Waters* — Concluded.

[Parts in 100,000.]

Bedford, large well,	5.71	Reading, filter gallery,	8.83
Dracut (Collinsville), tubular wells,	5.72	Manchester, tubular wells,	9.27
Braintree, filter gallery,	5.96	Brookline, tubular wells and filter gallery,	9.28
Provincetown, tubular wells in Truro,	6.04	Framingham, filter gallery,	9.31
Middleborough, well,	6.24	Cohasset, large well,	10.10
Leicester, wells,	6.30	Woburn, filter gallery and wells,	10.33
Needham, well No. 1,	6.41	Dedham, large well and tubular wells,	10.44
Fairhaven, tubular wells,	6.50	Sharon, well,	10.88
Newton, tubular wells and filter gallery,	6.57	Grafton, filter gallery,	11.23
North Attleborough, old well,	6.59	Provincetown, old wells,	11.45
Needham, well No. 2,	6.60	Wellesley, well at Williams Spring,	11.59
Billerica, tubular wells,	6.65	Manchester, large well,	11.60
Easthampton, tubular wells,	7.00	Amesbury, Main Street wells,	11.76
Methuen, tubular wells,	7.29	Cohasset, filter gallery,	11.89
Franklin, tubular wells, old,	7.40	Cohasset, tubular wells No. 2,	12.10
Dracut (Water Supply District), tubular wells.	7.42	Newburyport, wells and springs,	12.50
Ware, wells,	7.72	Hopkinton, wells,	12.69
Waltham, new well,	7.89	Marshfield, well,	13.15
Bridgewater, wells,	7.92	Reading, filtered water,	13.30
Waltham, old well,	7.93	Hyde Park, tubular wells near Neponset River.	13.79
Millis, spring,	8.18	Cohasset, tubular wells No. 1,	14.03
Weston, well,	8.22	Adams, tubular wells,	14.26
Natick, large well,	8.38	Scituate, tubular wells,	16.12
Wellesley, tubular wells,	8.62	Marblehead, large well No. 2,	18.98
Hyde Park, tubular wells near Mother Brook,	8.66	Amesbury, Market Street wells,	26.56

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

All of the larger rivers of the State are polluted to a greater or less degree by the sewage of cities or towns or by manufacturing wastes from factories and mills located upon their banks. In some cases the pollution is slight, and the stream is offensive neither to sight nor smell, except in the immediate vicinity of the outlet of a sewer or just below a mill. In extreme cases, however, the pollution is so great that the stream is rendered filthy and offensive for many miles.

The flow of streams during the year 1909 was less than the average, and in some cases less than in 1908. In the southeasterly portion of the State the flow was somewhat greater and better maintained than in 1908, on account of the slightly greater rainfall and its more even distribution throughout the year.

On most of the important streams of the State stations were established several years ago, at which samples have been collected for chemical examination. These samples are generally collected monthly during the six driest months of the year, — June to November inclusive, — although there are a few cases in which they are collected monthly throughout the year. During the year 1909 chemical analyses were made of samples of water collected from the following streams: —

Assabet.	Millers.
Blackstone.	Nashua.
Charles.	Nemasket.
Chicopee.	Neponset.
Concord.	Quaboag.
Connecticut.	Quinebaug.
Deerfield.	Salisbury Plain.
French.	Shawsheen.
Green.	Sudbury.
Hoosick.	Taunton.
Housatonic.	Ten Mile.
Merrimack.	Ware.
Mill (Northampton).	Westfield.

A summary of the various analyses showing the condition of the Blackstone, Charles, Hoosick, Merrimack, Nashua, Neponset, Taunton and Ware rivers for such years as these records are available is appended.

Blackstone River.

Chemical Examination of Water from Blackstone River. — Averages for Six Months, from June to November, 1887 to 1909, inclusive.

Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887,	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888,	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
" " 1889,	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890,	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
" " 1891,	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
" " 1892,	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
" " 1893,	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
" " 1894,	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
" " 1895,	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
" " 1896,	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
" " 1897,	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2
" " 1898,	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
" " 1899,	0.14	34.38	10.60	.2583	.0788	.0390	.0398	–	–	.0004	14.3
" " 1900,	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6
" " 1901,	0.23	31.03	11.68	.1410	.0548	.0309	.0239	–	–	.0023	13.8
" " 1902,	0.10	46.15	12.47	.2453	.0728	.0274	.0454	–	–	.0010	16.5
" " 1903,	0.18	24.06	6.80	.2836	.0750	.0472	.0278	–	–	.0027	8.4
" " 1904,	0.12	44.68	17.08	.1228	.0434	.0225	.0209	–	–	.0008	14.7
" " 1905,	0.21	50.36	19.49	.0952	.0492	.0203	.0289	–	–	.0003	29.3
" " 1906,	0.11	40.07	15.25	.0688	.0421	.0189	.0232	–	.0032	.0002	20.3
" " 1907,	0.04	44.07	17.67	.0613	.0343	.0180	.0163	–	–	.0003	–
" " 1908,	0.16	23.67	5.55	.0990	.0291	.0153	.0138	3.23	.0134	.0014	–
" " 1909,	–	52.97	18.55	.1865	.0381	.0239	.0142	4.80	.0033	.0010	8.4

Blackstone River, below Sewage Precipitation Works.

Months.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
June-Nov., 1887,	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888,	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
" " 1889,	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890,	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
" " 1891,	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
" " 1892,	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
" " 1893,	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
" " 1894,	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
" " 1895,	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
" " 1896,	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
" " 1897,	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
" " 1898,	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0132	.0119	9.2
" " 1899,	0.14	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108	.0068	16.1
" " 1900,	0.22	24.57	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3
" " 1901,	0.09	31.12	6.90	.4580	.1293	.0772	.0521	3.42	.0090	.0058	10.8
" " 1902,	0.15	49.62	13.38	.7296	.1284	.0736	.0548	2.97	–	.0033	12.5
" " 1903,	0.39	31.08	9.48	.3880	.1080	.0545	.0535	–	–	.0062	10.4
" " 1904,	–	50.25	13.73	.6381	.1523	.0601	.0922	–	–	.0027	16.9
" " 1905,	0.19	59.84	17.97	.4936	.0985	.0597	.0388	–	–	.0008	29.3
" " 1906,	0.19	49.69	11.42	.6330	.1818	.0580	.1238	–	.0058	.0130	15.0
" " 1907,	0.37	40.40	7.87	.7600	.0837	.0580	.0257	5.15	.0255	.0061	–
" " 1908,	0.46	37.70	6.82	1.1317	.1362	.0919	.0443	6.80	.0078	.0040	–
" " 1909,	–	48.82	9.29	1.2200	.1072	.0777	.0295	8.20	.0140	.0069	3.5

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER, ETC. — *Concluded.*

Blackstone River, at Uxbridge.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	.39	–	–	.1129	.0271	–	–	0.79	.0360	–	–
" " 1888,	.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	–
" " 1889,	.32	–	–	.1133	.0296	.0192	.0104	0.66	.0333	.0009	–
" " 1890,	.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
" " 1891,	.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
" " 1892,	.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
" " 1893,	.24	11.74	2 37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
" " 1894,	.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
" " 1895,	.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
" " 1896,	.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
" " 1897,	.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3
" " 1898,	.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
" " 1899,	.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
" " 1900,	.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0
" " 1901,	.22	13.91	2.67	.3159	.0285	.0240	.0045	1.50	.0195	.0035	5.0
" " 1902,	.15	14.17	2.56	.3462	.0270	.0218	.0052	1.95	.0210	.0018	4.9
" " 1903,	.30	13.16	2.52	.3030	.0262	.0215	.0047	1.74	.0210	.0024	4.4
" " 1904,	.20	13.78	2.74	.2399	.0282	.0214	.0068	2.12	.0408	.0022	4.6
" " 1905,	.21	16.34	2.55	.3928	.0246	.0203	.0043	2.65	.0175	.0025	5.0
" " 1906,	.19	14.73	3.10	.2218	.0242	.0200	.0042	2.10	.0252	.0009	4.2
" " 1907,	.37	14.23	2.58	.2331	.0238	.0182	.0056	2.36	.0330	.0040	4.5
" " 1908,	.31	16.33	4.07	.2387	.0258	.0196	.0057	3.05	.0408	.0071	–
" " 1909,	.22	18.31	4.35	.3473	.0273	.0216	.0057	3.64	.0325	.0066	–

Blackstone River, at Millville.

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	.31	–	–	.0468	.0220	–	–	0.51	.0210	–	–
" " 1888,	.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	–
" " 1889,	.38	–	–	.0499	.0273	.0213	.0060	0.45	.0167	.0003	–
" " 1890,	.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
" " 1891,	.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
" " 1892,	.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
" " 1893,	.23	7.43	1.73	.0677	.0119	.0087	.0032	0.77	.0385	.0011	2.6
" " 1894,	.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
" " 1895,	.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
" " 1896,	.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3
" " 1897,	.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
" " 1898,	.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
" " 1899,	.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
" " 1900,	.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4
" " 1901,	.31	8.62	2.13	.1420	.0288	.0227	.0061	0.87	.0155	.0006	3.1
" " 1902,	.28	9.43	2.24	.1623	.0284	.0238	.0046	1.20	.0195	.0010	2.8
" " 1903,	.33	8.46	1.85	.1397	.0233	.0189	.0044	1.10	.0192	.0010	2.9
" " 1904,	.29	8.71	2.06	.1079	.0235	.0201	.0034	1.26	.0337	.0009	2.9
" " 1905,	.28	10.76	2.03	.1956	.0311	.0222	.0089	1.67	.0207	.0008	2.9
" " 1906,	.37	9.02	2.15	.1526	.0306	.0251	.0055	1.27	.0188	.0006	2.4
" " 1907,	.37	10.43	2.21	.1521	.0240	.0181	.0059	1.61	.0247	.0014	3.1
" " 1908,	.33	9.85	2.53	.1295	.0232	.0185	.0047	1.78	.0258	.0024	3.4
" " 1909,	.24	11.87	3.17	.1595	.0267	.0220	.0047	2.27	.0225	.0019	–

NOTE. — The sewage purification works of the city of Worcester were put in operation in 1890, since which time a portion of the sewage of the city has been treated. The works were enlarged in 1893, and since that time practically all of the dry-weather flow of sewage has been treated.

CHARLES RIVER.

Charles River.

Chemical Examination of Water from Charles River. — Averages for Six Months, from June to November, 1887 to 1909, inclusive.

Charles River, opposite Pumping Station of Waltham Water Works.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
June-Nov., 1887, .	.67	6.02	1.62	.0029	.0274	–	–	.48	.0043	–	–	–
" " 1888, .	.82	5.47	1.88	.0035	.0310	.0265	.0045	.41	.0087	.0002	–	–
" " 1897, .	.95	6.06	2.45	.0056	.0322	.0299	.0023	.53	.0073	.0002	.83	1.9
" " 1898, .	.81	5.74	2.46	.0050	.0329	.0296	.0033	.44	.0043	.0001	.85	1.6
" " 1899, .	.41	5.50	1.81	.0047	.0264	.0248	.0016	.51	.0051	.0002	.52	1.9
" " 1900, .	.52	5.93	1.68	.0064	.0282	.0259	.0023	.53	.0070	.0002	.58	1.7
" " 1901, .	.82	5.93	2.72	.0065	.0322	.0289	.0033	.44	.0067	.0002	.85	1.8
" " 1902, .	.45	6.21	1.97	.0084	.0258	.0228	.0030	.62	.0077	.0003	.59	2.0
" " 1903, .	.64	6.06	2.21	.0078	.0267	.0239	.0028	.58	.0084	.0003	.71	2.0
" " 1904, .	.55	6.08	2.22	.0062	.0317	.0266	.0051	.62	.0095	.0002	.62	2.0
" " 1905, .	.79	6.29	2.54	.0077	.0363	.0308	.0055	.58	.0075	.0002	.80	1.7
" " 1906, .	1.00	6.70	2.58	.0063	.0335	.0297	.0038	.59	.0038	.0002	.98	1.8
" " 1907, .	.58	6.22	2.24	.0067	.0278	.0247	.0031	.63	.0058	.0002	.65	2.0[1]
" " 1908, .	.62	6.50	2.49	.0048	.0344	.0284	.0060	.69	.0027	.0001	.64	1.9
" " 1909, .	.54	6.79	2.36	.0063	.0349	.0298	.0051	.76	.0026	.0002	.53	2.0

[1] July omitted.

HOOSICK RIVER.

Hoosick River.

Chemical Examination of Water from Hoosick River. — Averages for Six Months, from June to November, 1887 to 1909, inclusive.

Hoosick River, at Williamstown.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
June-Nov., 1887, .	.22	12.05	1.22	.0065	.0190	–	–	.23	.0232	–	–	–
" " 1888, .	.12	10.82	1.90	.0026	.0210	.0142	.0068	.27	.0247	.0015	–	–
" " 1894, .	.37	13.56	2.74	.0166	.0361	.0224	.0137	.50	.0102	.0014	.42	9.0
" " 1895, .	.34	14.20	3.26	.0190	.0424	.0241	.0183	.63	.0090	.0020	.53	9.0
" " 1896, .	.21	11.71	2.39	.0295	.0267	.0172	.0095	.39	.0133	.0018	.33	8.6
" " 1897, .	.26	11.32	2.39	.0174	.0312	.0173	.0139	.30	.0265	.0011	.31	7.9
" " 1898, .	.27	10.46	2.38	.0223	.0311	.0210	.0101	.31	.0170	.0007	.34	6.6
" " 1899, .	.30	15.21	3.31	.0252	.0622	.0379	.0243	.64	.0070	.0029	.62	8.3
" " 1900, .	.28	14.20	2.79	.0433	.0547	.0301	.0246	.60	.0087	.0043	.58	7.8
" " 1901, .	.27	13.02	3.70	.0400	.0520	.0250	.0270	.43	.0152	.0024	.53	7.3
" " 1902, .	.22	10.62	2.87	.0069	.0307	.0172	.0135	.34	.0123	.0014	.40	6.4
" " 1903, .	.17	10.50	2.37	.0272	.0264	.0151	.0113	.29	.0183	.0019	.33	7.5
" " 1904, .	.13	12.30	3.23	.0677	.0310	.0191	.0119	.45	.0203	.0024	.29	8.3
" " 1905, .	.20	11.09	2.81	.0295	.0265	.0156	.0109	.32	.0123	.0015	.31	5.6
" " 1906, .	.31	13.28	3.63	.0415	.0489	.0252	.0237	.47	.0147	.0030	.43	6.0
" " 1907, .	.25	11.80	2.93	.0431	.0390	.0231	.0159	.47	.0135	.0021	.39	7.9
" " 1908, .	.23	14.00	3.86	.0559	.0323	.0195	.0128	.54	.0085	.0023	.37	–
" " 1909, .	.23	15.46	4.09	.0496	.0382	.0243	.0139	.62	.0060	.0035	.41	–

Merrimack River.

Table comparing the Analyses above Lowell with those above Lawrence, 1909.

[Parts in 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
Mean of analyses above Lowell.	.34	4.45	1.99	.0135	.0190	.0145	.0045	.29	.0034	.0001	1.4
Mean of analyses above Lawrence.	.35	5.64	2.18	.0221	.0236	.0175	.0061	.42	.0037	.0005	1.6
Increase, . . .	.01	1.19	0.19	.0086	.0046	.0030	.0016	.13	.0003	.0004	0.2

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years.

Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.

[Parts in 100,000.]

Date.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
Increase, 1887–1889, .	0.01	0.23	0.09	.0007	.0027	.0017	.0010	.026	.0003[1]	.0000	–
Increase, 1890, . .	0.05	0.62	0.22[1]	.0016	.0023	.0017	.0006	.028	.0020[1]	.0000	0.2
Increase, 1891, . . .	0.02[1]	0.29	0.07	.0021	.0023	.0021	.0002	.035	.0030[1]	.0000	0.1
Increase, 1892, . . .	0.06	0.48	0.12	.0019	.0037	.0037	.0000	.039	.0013[1]	.0000	0.0
Increase, 1893, . . .	0.09	0.47	0.30	.0031	.0032	.0021	.0011	.035	.0002[1]	.0001	0.0
Increase, 1894, . . .	0.02	0.15	0.04	.0028	.0032	.0032	.0000	.049	.0000	.0000	0.1
Increase, 1895, . . .	0.11	0.52	0.33	.0022	.0063	.0046	.0017	.063	.0005	.0001	0.1
Increase, 1896, . . .	0.02	0.51	0.24	.0034	.0053	.0047	.0006	.070	.0017	.0002	0.2
Increase, 1897, . . .	0.06	0.30	0.08	.0019	.0051	.0033	.0018	.050	.0000	.0000	0.1
Increase, 1898, . . .	0.03	0.37	0.07	.0024	.0039	.0019	.0020	.044	.0010	.0002	0.1
Increase, 1899, . . .	0.02	0.39	0.07	.0038	.0045	.0023	.0022	.059	.0004[1]	.0001	0.1
Increase, 1900, . . .	0.03	0.41	0.11	.0037	.0027	.0026	.0001	.055	.0011	.0000	0.0
Increase, 1901, . . .	0.03	0.27	0.03	.0032	.0044	.0023	.0021	.053	.0020	.0003	0.3
Increase, 1902, . . .	0.03	0.52	0.20	.0032	.0063	.0027	.0036	.060	.0000	.0001	0.1
Increase, 1903, . . .	0.04	0.56	0.18	.0043	.0065	.0045	.0020	.072	.0014	.0002	0.2
Increase, 1904, . . .	0.02	0.31	0.06	.0092	.0047	.0026	.0021	.100	.0004[1]	.0001	0.1
Increase, 1905, . . .	0.04	0.44	0.09	.0047	.0042	.0024	.0018	.102	.0002	.0002	0.1
Increase, 1906, . . .	0.02	0.56	0.28	.0039	.0045	.0029	.0016	.100	.0004[1]	.0001	0.2
Increase, 1907, . . .	0.03	0.18	0.03[1]	.0128	.0053	.0036	.0017	.094	.0009	.0002	0.1
Increase, 1908, . . .	0.03	0.66	0.13	.0114	.0074	.0045	.0029	.130	.0003	.0002	0.2
Increase, 1909, . . .	0.01	1.19	0.19	.0086	.0046	.0030	.0016	.130	.0003	.0004	0.2

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 5,434, 8,126, 5,459, 11,634, 5,886, 8,230, 9,402, 7,406, 7,389, 8,524, 9,160, 9,674, 7,410, 7,451, 8,484, 7,123, 6,716 and 5,230 cubic feet per second.

[1] Decrease.

NASHUA RIVER.

Nashua River.

Chemical Examination of Water from the North Branch of the Nashua River. — Averages for Six Months, from June to November, 1893 to 1909, inclusive.

North Branch of Nashua River, below Fitchburg.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
June-Nov., 1893, .	.70	8.32	2.38	.0562	.0405	.0289	.0116	.73	.0097	.0030	.73	2.2
" " 1894, .	.66	9.18	2.22	.0987	.0425	.0308	.0117	.99	.0123	.0034	.64	2.4
" " 1895, .	.71	9.42	2.72	.1387	.0493	.0381	.0112	1.08	.0088	.0014	.82	2.6
" " 1896, .	.57	9.27	2.62	.0898	.0537	.0384	.0153	.95	.0127	.0030	.71	2.4
" " 1897, .	.67	7.62	2.50	.0512	.0518	.0389	.0129	.71	.0112	.0009	.79	2.1
" " 1898, .	.56	7.02	2.37	.0688	.0629	.0399	.0230	.56	.0097	.0016	.72	1.8
" " 1899, .	.53	10.12	2.95	.1507	.0848	.0537	.0311	1.03	.0055	.0013	.83	2.4
" " 1900, .	.42	9.55	2.42	.1575	.0825	.0479	.0346	1.03	.0080	.0015	.73	2.6
" " 1901, .	.42	8.45	2.58	.0964	.0508	.0347	.0161	.67	.0080	.0013	.69	2.2
" " 1902, .	.39	7.83	2.42	.1070	.0557	.0407	.0150	.68	.0072	.0012	.71	1.9
" " 1903, .	.38	7.21	2.10	.1200	.0471	.0281	.0190	.73	.0095	.0014	.62	1.7
" " 1904, .	.33	9.05	2.70	.1858	.0596	.0341	.0255	.88	.0077	.0015	.70	2.1
" " 1905, .	.48	7.66	2.33	.1284	.0568	.0354	.0214	.73	.0053	.0008	.89	2.1
" " 1906, .	.47	7.68	2.16	.1037	.0558	.0356	.0202	.75	.0083	.0020	.68	2.0
" " 1907, .	.50	10.77	2.72	.2180	.0654	.0350	.0304	1.24	.0065	.0012	.72	2.8
" " 1908, .	.52	15.05	3.60	.2605	.0861	.0494	.0367	1.58	.0033	.0016	1.04	–
" " 1909, .	.52	15.85	3.42	.3220	.0958	.0563	.0395	1.87	.0027	.0014	1.02	–

NEPONSET RIVER.

Neponset River.

Chemical Examination of Water from Neponset River. — Averages for Six Months, from June to November, 1887 to 1909, inclusive.

Neponset River, at Hyde Park.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
June-Nov., 1887, .	1.18	8.20	2.22	.0053	.0402	–	–	.98	.0077	–	–	–
" " 1888, .	1.12	7.77	2.37	.0040	.0392	.0358	.0034	1.08	.0074	.0003	–	–
" " 1893, .	1.27	8.60	2.68	.0233	.0370	.0282	.0088	1.47	.0045	.0009	1.00	2.6
" " 1894, .	1.19	12.87	3.03	.0196	.0466	.0333	.0133	2.31	.0033	.0002	1.03	4.1
" " 1895, .	.97	10.01	3.07	.0341	.0440	.0373	.0067	1.51	.0042	.0001	1.05	3.7
" " 1896, .	1.26	10.41	3.12	.0162	.0431	.0395	.0036	1.68	.0033	.0001	1.26	3.3
" " 1897, .	1.30	11.64	3.34	.0336	.0494	.0417	.0077	1.81	.0037	.0001	1.31	4.0
" " 1898, .	1.28	8.82	3.52	.0161	.0505	.0398	.0107	1.02	.0023	.0002	1.30	2.7
" " 1899, .	1.14	16.24	4.51	.0264	.0936	.0693	.0243	2.20	.0032	.0002	1.76	5.7
" " 1900, .	1.10	10.59	2.99	.0400	.0576	.0381	.0195	1.45	.0048	.0005	1.07	3.2
" " 1901, .	1.43	13.26	5.09	.0224	.0802	.0591	.0211	1.69	.0036	.0006	1.82	4.2
" " 1902, .	1.02	12.57	4.19	.0360	.0640	.0547	.0093	1.72	.0035	.0004	1.29	4.0
" " 1903, .	1.29	14.21	4.95	.0278	.0811	.0638	.0173	1.86	.0034	.0010	1.71	4.5
" " 1904, .	1.08	16.22	5.68	.0631	.1007	.0777	.0230	2.07	.0037	.0005	1.67	5.6
" " 1905, .	1.22	21.88	6.68	.0813	.1043	.0861	.0182	3.44	.0028	.0006	2.22	6.6
" " 1906, .	1.35	13.47	4.42	.0549	.0875	.0674	.0201	2.21	.0025	.0008	1.85	3.9
" " 1907, .	.90	22.58	6.31	.1201	.1412	.0961	.0451	3.81	.0042	.0004	1.94	6.9
" " 1908, .	–	25.40	7.19	.1132	.1209	.0844	.0365	5.08	.0027	.0006	2.01	8.8
" " 1909, .	–	28.69	9.08	.1723	.1218	.0898	.0320	5.35	.0027	.0009	2.02	10.0

Taunton River.

Chemical Examination of Water from Taunton River. — Averages for Six Months, from June to November, 1898 to 1909, inclusive.

Taunton River, below Taunton.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
June-Nov., 1898, .	1.56	6.64	3.30	.0109	.0345	.0314	.0031	.61	.0082	.0003	1.51	1.3
" " 1899, .	.93	6.31	2.48	.0176	.0317	.0279	.0038	.72	.0060	.0004	1.04	1.2
" " 1900, .	.71	6.89	1.91	.0205	.0286	.0258	.0028	1.06	.0112	.0006	.76	1.5
" " 1901, .	1.01	6.15	2.45	.0293	.0275	.0255	.0020	.76	.0134	.0005	.92	1.6
" " 1906,[1] .	1.41	7.37	3.11	.0401	.0385	.0331	.0054	.95	.0162	.0008	1.36	1.4
" " 1907,[2] .	.94	7.16	2.62	.1031	.0343	.0282	.0061	1.05	.0115	.0009	1.05	1.7
" " 1908, .	.73	7.66	2.52	.0469	.0278	.0226	.0052	1.31	.0108	.0011	.74	–
" " 1909, .	.90	12.97	3.87	.0416	.0303	.0263	.0040	3.49	.0105	.0014	.88	–

[1] June omitted. [2] June and July omitted.

Ware River.

Chemical Examination of Water from Ware River. — Averages for Six Months, from June to November, 1898 to 1909, inclusive.

Ware River, below Ware.

[Parts in 100,000.]

Months.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
June-Nov., 1898, .	.64	4.42	1.94	.0028	.0332	.0250	.0082	.19	.0025	.0003	.77	1.0
" " 1899, .	.46	4.82	1.77	.0052	.0371	.0268	.0103	.25	.0015	.0004	.66	0.9
" " 1900, .	.51	4.93	1.64	.0066	.0321	.0243	.0078	.25	.0030	.0003	.73	1.1
" " 1901, .	.73	4.79	2.15	.0082	.0300	.0242	.0058	.18	.0044	.0002	.84	1.3
" " 1902, .	.76	4.86	2.17	.0071	.0348	.0252	.0096	.23	.0040	.0003	.93	1.0
" " 1903,[1] .	.68	4.83	2.18	.0072	.0345	.0240	.0105	.25	.0034	.0003	.78	0.8
" " 1904,[1] .	.60	5.60	2.36	.0043	.0411	.0285	.0126	.29	.0046	.0004	.72	1.1
" " 1908, .	.56	7.38	2.86	.0265	.0418	.0264	.0154	.37	.0033	.0005	.80	–
" " 1909,[1] .	.61	8.63	3.05	.0354	.0569	.0357	.0212	.44	.0015	.0006	.98	–

[1] September omitted.

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

WATER SUPPLY STATISTICS.

During the year 1909 water supplies were introduced into the towns of Bedford (population, 1,208), Pepperell (population, 3,268) and Plainville (population, 1,300) and into the Blandford Fire District. New supplies were also introduced for the first time into the village of East Brookfield in the town of Brookfield and into the village of Bondsville in the town of Palmer. In each of these cases the village supplied is widely separated from the central portion of the town in which it is situated, and independent works were constructed.

Of the 354 cities and towns in Massachusetts, all of the 33 cities and 159 of the towns are provided with public water supplies. The following table gives the classification by population of the cities and towns having and not having public water supplies at the end of the year. The populations are taken from the census of 1905.

Population.	Number of Places of Given Population having Public Water Supplies.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having Public Water Supplies.	Total Population of Places in Preceding Column.
Under 500,	-	-	36	12,513
500–999,	5	4,501	49	36,036
1,000–1,499,	18	21,914	32	39,977
1,500–1,999,	13	23,445	22	38,534
2,000–2,499,	14	30,706	14	29,761
2,500–2,999,	13	35,009	2	5,517
3,000–3,499,	9	29,211	1	3,173
3,500–3,999,	5	18,931	3	11,394
Above 4,000,	115	2,648,521	3	14,537
Total,	192	2,812,238	162	191,442

The 192 cities and towns having public water supplies are classified in the following table according to the dates when a fairly complete system of water supply was first introduced: —

Years.	Number of Places supplied.	Years.	Number of Places supplied.
Previous to 1850,	7	1880–1889, inclusive,	72
1850–1859, inclusive,	4	1890–1899, inclusive,	34
1860–1869, inclusive,	9	1900–1909, inclusive,	21
1870–1879, inclusive,	45	Total,	192

The following table gives certain statistics relative to the number of cities and towns and the total population supplied with water from surface and ground-water sources: —

Sources of Supply.	Number of Places.	Population supplied.	Per Cent. of Total Population of All Places supplied.
Surface,	100	2,221,164	79
Ground,	72	467,526	17
Surface and ground,	20	123,548	4
Total,	192	2,812,238	100

From the totals given in the first table it will be seen that although but 54 per cent. of the cities and towns in the State have a public water supply, the total population of the places supplied is 94 per cent. of the total population of the State. The populations given in the foregoing tables were obtained by using the total population of the cities and towns supplied, and is somewhat greater than the actual number of persons to whom the public water supply is available, but the difference is not great.

All of the towns, except Blackstone, having a population in excess of 5,000 are supplied with water, and there are only 9 towns in the State having a population in excess of 2,500 which are not provided with public water supplies. These towns are as follows: —

Town.	Population 1905.	Town.	Population 1905.
Blackstone,	5,786	Templeton,	3,783
Tewksbury,	4,415	Sutton,	3,173
Barnstable,	4,336	Westport,	2,867
Dudley,[1]	3,818	Medway,	2,650
Dartmouth,	3,793		

[1] Works under construction.

At the present time the water works are owned either by the municipality or by a fire or water supply district in all of the cities and 114 of the towns, while in 45 towns the works are owned by private companies. The following table gives the classification by population of the cities and towns which own their water works and those which are supplied with water by private companies: —

Population, 1905.	Number of Places of Given Population owning Water Works.	Total Population of Places in Preceding Column.	Number of Places of Given Population supplied with Water by Private Companies.	Total Population of Places in Preceding Column.
Under 1,000,	3	2,632	2	1,869
1,000–1,999,	22	33,275	9	12,084
2,000–2,999,	13	31,614	14	34,101
3,000–3,999,	8	27,487	6	20,655
4,000–4,999,	13	57,088	5	22,410
5,000–5,999,	12	65,487	2	10,365
6,000–6,999,	12	77,889	1	6,754
7,000–7,999,	7	50,508	3	22,929
Above 8,000,	57	2,297,476	3	37,615
Total,	147	2,643,456	45	168,782

The tendency toward municipal ownership of water supplies is shown in the following table, giving, for census years since 1890, the total population of all cities and towns supplied with water, the population of those places supplied by private companies and its percentage of the total population of all places supplied: —

Year.	Total Population of All Places supplied with Water.	Population of Places supplied by Private Companies.	Per Cent. of Total.
1890,	1,924,812	318,319	16.5
1895,	2,237,017	212,579	9.5
1900,	2,565,301	236,869	9.2
1905,	2,792,490	193,290	6.9

Since 1905 the percentage has been still further decreased, and at the end of the year 1909 the total population of the towns supplied with water by private companies was only 6 per cent. of the total population of all of the cities and towns supplied with water, and there are now

only 9 towns having a population in excess of 5,000 which are supplied by private companies, namely, Hyde Park,[1] Milford, Southbridge, Dedham, Palmer, Northbridge, Bridgewater, Amherst and Grafton.

Consumption of Water.

Records of the consumption of water are kept in nearly all of the cities and towns where water is pumped, and in several places supplied by gravity Venturi meters are used to measure the quantity supplied.

The following table gives statistics with regard to the consumption of water in the year 1909 in those cities and towns where such records are kept. The estimated population given in this table is obtained by adding four-fifths of the increase in population from 1900 to 1905 to the population as determined by the census taken in the latter year. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the estimated total population of the city or town in 1909. The quantity obtained in this manner is somewhat less than the actual consumption per person using the water, because there are in all cities and towns a greater or less number of persons who do not use the public supply. This difference is most marked in towns containing villages to which the public water supply has not been extended, and in towns where the works have been in operation but a short time and where water has not come into general use. In some towns the population during the summer months is much greater than that which is shown by census returns, and in such cases the consumption per inhabitant as given in the table is higher than it would be if allowance were made for the increased population in the summer. With a few exceptions, however, the difference is not great.

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[1] Town of Hyde Park voted early in January, 1906, to take the works of the Hyde Park Water Company.

Statistics relating to the Consumption of Water in Various Cities and Towns.

City or Town.	Estimated Population, 1909.	Average Daily Consumption (Gallons), 1909.	Daily Consumption per Inhabitant (Gallons), 1909.	City or Town.	Estimated Population, 1909.	Average Daily Consumption (Gallons), 1909.	Daily Consumption per Inhabitant (Gallons), 1909.
Metropolitan water district:[1] —	1,010,562	122,584,000	121	Concord, . . .	5,236	452,000	86
Arlington, . .	10,520	861,000	82	Danvers and Middleton.	10,731	774,000	72
Belmont, . .	4,705	310,000	66	Dedham, . . .	8,028	1,160,000	144
Boston,[2] . .	655,544	94,030,000	143	Easton, . . .	4,967	124,000	25
Chelsea,[2] . .	33,419	2,869,000	86	Fall River,[2] . .	116,588	5,340,000	46
Everett,[2] . .	32,609	2,641,000	81	Falmouth, . .	3,034	324,000	107
Lexington, .	5,089	329,000	65	Foxborough, . .	3,442	182,000	53
Malden,[2] . .	43,131	1,848,000	43	Framingham, . .	11,745	563,000	48
Medford, . .	20,840	1,732,000	83	Franklin, . . .	5,426	279,000	51
Melrose, . .	15,361	962,000	63	Gardner, . . .	12,971	742,000	57
Milton, . .	7,435	313,000	42	Gloucester, . .	25,923	1,379,000	53
Nahant, . .	738	124,000	168	Groton, . . .	2,414	76,000	31
Quincy,[2] . .	31,729	2,919,000	92	Holliston, . . .	2,715	49,000	18
Revere, . .	14,470	1,251,000	86	Holyoke,[2] . . .	56,171	5,614,000	100
Somerville,[2] .	75,643	6,331,000	84	Hyde Park, . .	15,523	1,121,000	72
Stoneham, .	6,440	575,000	89	Ipswich, . . .	5,643	245,000	43
Swampscott, .	5,615	388,000	69	Lancaster, . . .	2,348	94,000	40
Watertown, .	12,500	755,000	60	Lawrence,[2] . .	82,724	3,566,000	43
Winthrop, . .	7,815	878,000	112	Lowell,[2] . . .	104,013	5,240,000	50
Abington and Rockland.	12,850	520,000	40	Lynn and Saugus,[2]	94,065	6,394,000	68
Amesbury, . .	8,334	402,000	48	Manchester, . .	2,695	303,000	112
Andover, . . .	6,487	556,000	86	Mansfield, . . .	4,436	347,000	78
Attleborough, . .	13,796	826,000	60	Marblehead, . .	6,911	664,000	96
Avon, ...	2,029	78,000	38	Marlborough, . .	14,444	572,000	40
Ayer, ...	2,338	126,000	54	Maynard, . . .	7,946	234,000	29
Beverly, . . .	16,294	1,642,000	101	Merrimac, . . .	1,686	88,000	52
Billerica, . . .	2,897	107,000	37	Methuen, . . .	9,607	400,000	42
Bridgewater and East Bridgewater.	10,797	239,000	22	Middleborough, .	6,890	344,000	50
Brockton,[2] . .	55,061	2,086,000	38	Milford and Hopedale.	14,705	743,000	51
Brookline,[2] . .	26,921	2,314,000	86	Millbury, . . .	4,768	206,000	43
Cambridge,[2] . .	103,358	9,859,000	95	Nantucket, . .	2,869	173,000	60
Canton, . . .	4,796	287,000	59	Natick, . . .	9,706	568,000	59
Clinton, . . .	12,655	596,000	47	Needham, . . .	4,498	335,000	75

[1] Including Newton and Hyde Park, which are within the district, but supplied from independent works.

[2] Population obtained by adding four-fifths of the increase in population from 1905 to 1910 to the population as given in the census of the former year.

Statistics relating to the Consumption of Water in Various Cities and Towns — Concluded.

City or Town.	Estimated Population, 1909.	Average Daily Consumption (Gallons), 1909.	Daily Consumption per Inhabitant (Gallons), 1909.	City or Town.	Estimated Population, 1909.	Average Daily Consumption (Gallons), 1909.	Daily Consumption per Inhabitant (Gallons), 1909.
New Bedford,[1] .	92,194	7,472,000	81	Sharon, . . .	2,105	122,000	58
Newburyport, . .	14,833	908,000	61	Shirley, . . .	1,702	45,000	26
Newton,[1] . . .	39,210	2,344,000	60	Taunton,[1] . . .	33,601	2,168,000	65
North Andover, .	4,911	233,000	47	Wakefield, . . .	11,050	698,000	63
North Attleborough,	8,378	396,000	47	Walpole, . . .	4,348	397,000	91
North Brookfield, .	1,041	169,000	162	Waltham,[1] . . .	27,524	2,382,000	87
Norwood, . . .	7,732	478,000	62	Ware, ...	8,859	429,000	48
Oak Bluffs, . .	1,168	148,000	127	Wareham, . . .	3,842	89,000	23
Orange, . . .	5,624	141,000	25	Webster, . . .	10,989	430,000	39
Peabody, . . .	14,358	2,371,000	165	Wellesley, . . .	7,083	324,000	46
Plymouth, . .	12,341	1,267,000	103	Westford, . . .	2,244	39,000	17
Provincetown, . .	4,454	167,000	38	Weston, . . .	2,297	84,000	37
Randolph and Holbrook.	6,800	451,000	66	Whitman, . . .	6,814	201,000	30
Reading, . . .	6,252	186,000	30	Winchendon, . .	6,679	152,000	23
Rockport, . . .	4,331	309,000	71	Woburn, . . .	14,520	1,803,000	124
Rutland, . . .	2,016	112,000	56	Worcester,[1] . .	142,416	8,930,000	63
Salem,[1] . . .	42,483	3,619,000	85	Wrentham, . .	1,437	48,000	33
Scituate, . . .	2,699	145,000	54				

[1] Population obtained by adding four-fifths of the increase in population from 1905 to 1910 to the population as given in the census of the former year.

Rainfall.

The average rainfall in Massachusetts as deduced from long-continued observations in various parts of the State is 45.16 inches. The average rainfall for the year 1909 in these places was 42.10 inches, an average deficiency of 3.06 inches. There was an excess in the months of January, February, April and September, but in the remaining eight months there was a deficiency. The greatest excess in any one month occurred in February, when the rainfall was 5.83 inches, and the greatest deficiency occurred in October, when the rainfall was 1.57 inches.

The following table gives the normal rainfall in the State for each month as deduced from observations at various places for a long period of years, together with the average rainfall for these places for each month during 1909 and the departure from the normal: —

Month.	Normal Rainfall (Inches).	Rainfall in 1909 (Inches).	Excess or Deficiency in 1909 (Inches).	Month.	Normal Rainfall (Inches).	Rainfall in 1909 (Inches).	Excess or Deficiency in 1909 (Inches).
January, . .	3.78	3.90	+0.12	August, . .	4.13	3.33	−0.80
February, . .	3.78	5.83	+2.05	September, .	3.56	4.84	+1.28
March, . .	4.06	3.56	−0.50	October, . .	3.92	1.57	−2.35
April, . . .	3.56	5.39	+1.83	November, .	3.88	3.27	−0.61
May, . . .	3.71	2.88	−0.83	December, .	3.63	3.34	−0.29
June, . . .	3.37	2.40	−0.97				
July, . . .	3.78	1.79	−1.99	Total, . .	45.16	42.10	−3.06

Taking the State as a whole there has been a deficiency of rainfall in every year since 1903, and the accumulated deficiency at the end of the year 1909 was 22.14 inches, or an average annual deficiency of 3.69 inches. This deficiency was not distributed equally throughout the period, however, but was only 0.67 of an inch in 1907 and 1.35 and 1.95 inches, respectively, in 1904 and 1906. About 68 per cent. of the total accumulated deficiency occurred in 1905 and 1908, when the deficiencies were 7.56 and 7.55 inches, respectively. The deficiency in 1909, as shown by the preceding table, was 3.06 inches, or 14 per cent. of the total deficiency for the period. The rainfall for the year 1909 was considerably greater than in 1908, but, as in that year, was unequally distributed, the average amount at Lowell, Chestnut Hill, Taunton and New Bedford, in the eastern part of the State, being 44.96 inches, while the average amount at Williamstown, Pittsfield, Amherst and Springfield, in the western part of the State, was only 38.40 inches. The effect of a year of low rainfall following so dry a year as that of 1908, with both of these years succeeding a series of dry years of somewhat less than the normal rainfall, has been to produce a heavy draft upon the ponds and storage reservoirs used as sources of water supply, and reducing many of them to a lower level than ever before. The effect in 1909 was more noticeable than in 1908 in those cities and towns which depend for their water supply upon lakes and reservoirs of considerable storage capacity, and, probably on account of the somewhat greater rainfall and its more even distribution, whereby the flow of small streams has been comparatively well maintained throughout the year, has been less noticeable in those cities and towns which derive their supply from large watersheds with comparatively small storage.

During the past year temporary sources of supply had to be secured in a number of places in which the quantity of water available in 1908 was sufficient, while in other places where temporary sources were used in 1908 the quantity obtained from the regular sources during the past year has been sufficient for all requirements.

Flow of Streams.

Sudbury River.

The average flow of the Sudbury River during the year 1909 was 625,000 gallons per day per square mile, or 60 per cent. of the normal flow for the past thirty-five years. In that period there have been only two years in which the average flow was less, namely, 1880 and 1883, when the flow was 578,000 and 533,000 gallons per day per square mile respectively. In 1909 the flow during the month of February was in excess of the normal, but during the remaining eleven months of the year it was less than the normal, the greatest deficiencies occurring in the months of January, March, November and December. During the months of July, August and October the flow was less than the evaporation from the water surfaces of the reservoirs, so that the flow is represented by a minus quantity. The average flow for the driest six months, June to November, inclusive, was 40,000 gallons per day per square mile, or 9.6 per cent. of the normal flow and 43 per cent. of the minimum flow ever before recorded for a similar period during the past thirty-five years.

In order to show the relation between the flow of the Sudbury River during each month of the year 1909 and the normal flow of that stream as deduced from observations during thirty-five years, from 1875 to 1909, inclusive, the following table has been prepared. The area of the watershed of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Monthly Flow of the Sudbury River for the Year 1909, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

Month.	Normal Flow.		Actual Flow in 1909.		Excess or Deficiency.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.888	1.220	0.607	0.392	—1.281	—0.828
February,	2.726	1.762	3.537	2.286	+0.811	+0.524
March,	4.427	2.861	2.683	1.734	—1.744	—1.127
April,	3.162	2.043	2.662	1.721	—0.500	—0.322
May,	1.704	1.101	1.553	1.004	—0.151	—0.097
June,	0.797	0.515	0.370	0.239	—0.427	—0.276
July,	0.276	0.178	—0.187	—0.121	—0.463	—0.299
August,	0.397	0.256	—0.069	—0.045	—0.466	—0.301
September,	0.399	0.258	0.231	0.149	—0.168	—0.109
October,	0.724	0.468	—0.079	—0.051	—0.803	—0.519
November,	1.281	0.828	0.127	0.082	—1.154	—0.746
December,	1.611	1.041	0.407	0.263	—1.204	—0.778
Average for whole year,	1.610	1.040	0.967	0.625	—0.643	—0.415

In the annual report of the State Board of Health for the year 1908 (pages 234 to 239) a table was presented giving the records of rainfall upon the Sudbury River watershed and the yield expressed in inches in depth on the watershed (inches of rainfall collected) for thirty-four years, from 1875 to 1908, inclusive. The corresponding record for the year 1909, together with the average for the whole period of thirty-five years, is given in the following table: —

Rainfall, in Inches, received and collected on the Sudbury River Watershed.

Month.	For the Year 1909.			Mean for Thirty-five Years, 1875–1909.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	3.98	0.700	17.6	4.14	2.177	52.6
February,	5.80	3.684	63.6	4.22	2.861	67.8
March,	4.26	3.093	72.7	4.49	5.104	113.6
April,	4.67	2.970	63.6	3.54	3.527	99.7
May,	2.42	1.791	73.9	3.40	1.964	57.8
June,	2.81	0.413	1.5	3.10	0.889	28.6
July,	1.59	—0.216	—1.4	3.60	0.318	8.8
August,	2.93	—0.080	—2.7	3.88	0.457	11.8
September,	4.74	0.257	5.4	3.55	0.445	12.5
October,	1.12	—0.091	—8.1	3.99	0.835	20.9
November,	3.38	0.142	4.2	3.83	1.429	37.3
December,	4.05	0.469	11.6	3.85	1.858	48.3
Year,	41.75	13.132	31.5	45.59	21.864	48.0

The following table gives the records of the yield of the Sudbury River watershed for each year during the past thirty-five years, the flow from the watershed being expressed in gallons per day per square mile of watershed in order to render the table more convenient for use in estimating the probable yield of watersheds used as sources of water supply: —

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile.[1]

Month.	1875.	1876.	1877.	1878.	1879.	1880.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000
June,	870,000	222,000	597,000	506,000	413,000	176,000
July,	321,000	183,000	202,000	128,000	158,000	177,000
August,	396,000	405,000	121,000	475,000	395,000	119,000
September,	207,000	184,000	60,000	160,000	141,000	80,000
October,	646,000	234,000	632,000	516,000	71,000	101,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000
December,	584,000	454,000	1,289,000	3,177,000	462,000	175,000
Average for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000
Average for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000

[1] The area of the Sudbury River watershed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

Month.	1881.	1882.	1883.	1884.	1885.	1886.
January,	415,000	1,241,000	335,000	995,000	1,235,000	1,461,000
February,	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,800,000
March,	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000
April,	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000
May,	965,000	1,292,000	938,000	1,030,000	1,336,000	720,000
June,	1,338,000	529,000	300,000	417,000	426,000	203,000
July,	276,000	86,000	115,000	224,000	62,000	115,000
August,	148,000	55,000	78,000	257,000	240,000	94,000
September,	197,000	306,000	91,000	44,000	121,000	118,000
October,	186,000	299,000	186,000	83,000	336,000	146,000
November,	395,000	210,000	205,000	175,000	1,178,000	673,000
December,	775,000	314,000	193,000	925,000	1,174,000	1,020,000
Average for whole year,	979,000	862,000	533,000	1,129,000	901,000	1,087,000
Average for driest six months,	330,000	211,000	145,000	200,000	391,000	223,000

Month.	1887.	1888.	1889.	1890.	1891.	1892.
January,	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000
February,	2,829,000	1,951,000	1,195,000	1,529,000	3,486,000	943,000
March,	2,868,000	3,237,000	1,339,000	3,643,000	4,453,000	1,955,000
April,	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000
May,	1,009,000	1,632,000	880,000	1,366,000	582,000	1,259,000
June,	414,000	422,000	653,000	568,000	414,000	428,000
July,	114,000	117,000	633,000	108,000	149,000	214,000
August,	214,000	380,000	1,432,000	132,000	163,000	280,000
September,	111,000	1,155,000	824,000	458,000	203,000	229,000
October,	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000
November,	368,000	2,758,000	1,941,000	1,215,000	305,000	697,000
December,	643,000	3,043,000	2,241,000	997,000	544,000	485,000
Average for whole year,	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000
Average for driest six months,	234,000	953,000	944,000	747,000	239,000	327,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

Month.	1893.	1894.	1895.	1896.	1897.	1898.
January,	433,000	693,000	1,034,000	1,084,000	845,000	1,638,000
February,	1,542,000	991,000	541,000	2,676,000	1,067,000	3,022,000
March,	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,604,000
April,	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	1,829,000
May,	2,883,000	840,000	636,000	360,000	915,000	1,246,000
June,	440,000	419,000	174,000	399,000	962,000	530,000
July,	158,000	161,000	231,000	95,000	658,000	231,000
August,	181,000	209,000	229,000	57,000	591,000	1,107,000
September,	108,000	150,000	89,000	388,000	182,000	369,000
October,	221,000	374,000	1,379,000	592,000	94,000	1,160,000
November,	319,000	836,000	2,777,000	659,000	909,000	1,986,000
December,	797,000	716,000	1,782,000	657,000	1,584,000	1,799,000
Average for whole year,	1,037,000	770,000	1,152,000	1,019,000	991,000	1,450,000
Average for driest six months,	237,000	356,000	460,000	314,000	564,000	777,000

Month.	1899.	1900.	1901.	1902.	1903.	1904.
January,	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000
February,	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,000
March,	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,999,000
April,	2,521,000	1,350,000	4,204,000	1,885,000	2,261,000	3,294,000
May,	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000
June,	66,000	316,000	753,000	303,000	1,987,000	419,000
July,	19,000	—18,000	306,000	66,000	445,000	62,000
August,	—35,000	—34,000	424,000	135,000	307,000	170,000
September,	94,000	65,000	305,000	178,000	130,000	397,000
October,	115,000	186,000	412,000	506,000	492,000	191,000
November,	304,000	663,000	474,000	444,000	363,000	289,000
December,	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000
Average for whole year,	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000
Average for driest six months,	93,000	194,000	445,000	271,000	388,000	228,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Concluded.

Month.	1905.	1906.	1907.	1908.	1909.	Mean for 35 Years, 1875-1909.
January,	1,410,000	1,128,000	1,351,000	1,925,000	392,000	1,220,000
February,	330,000	1,041,000	624,000	1,536,000	2,286,000	1,762,000
March,	2,497,000	2,409,000	1,658,000	2,257,000	1,734,000	2,861,000
April,	1,643,000	1,949,000	1,607,000	1,117,000	1,721,000	2,043,000
May,	297,000	1,059,000	888,000	1,046,000	1,004,000	1,101,000
June,	467,000	707,000	761,000	194,000	239,000	515,000
July,	177,000	398,000	9,000	—14,000	—121,000	178,000
August,	114,000	180,000	—104,000	102,000	—45,000	256,000
September,	1,246,000	19,000	541,000	—82,000	149,000	258,000
October,	158,000	301,000	741,000	47,000	—51,000	468,000
November,	279,000	483,000	1,998,000	71,000	82,000	828,000
December,	887,000	659,000	2,032,000	136,000	263,000	1,041,000
Average for whole year,	795,000	860,000	1,010,000	694,000	625,000	1,040,000
Average for driest six months,	403,000	341,000	471,000	44,000	40,000	415,000

Nashua River.

The average flow of the South Branch of the Nashua River above Clinton during the year 1909 was 918,000 gallons per day per square mile, or 79 per cent. of the normal flow for the past thirteen years. In that period there has been only one year in which the average flow was less, and that was 1908, when the flow was 847,000 gallons per day per square mile, or 73 per cent. of the normal. In 1909 the flow was in excess of the normal during the months of February and April and below the normal during the remaining ten months of the year. The greatest excess occurred in February and the greatest deficiencies in January, March and December.

In order to show the relation between the flow of the Nashua River during each month of the year 1909 and the normal flow of that stream as deduced from observations during thirteen years, from 1897 to 1909, inclusive, the following table is presented. The area of the watershed of the Nashua River above the point of measurement was 119 square miles from 1897 to 1907, inclusive, and 118.19 square miles in 1908 and 1909.

Table showing the Average Monthly Flow of the South Branch of the Nashua River for the Year 1909, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

Month.	Normal Flow.		Actual Flow in 1909.		Excess or Deficiency.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.851	1.196	0.916	0.592	—0.935	—0.604
February,	2.259	1.460	3.955	2.556	+1.696	+1.096
March,	4.329	2.798	3.295	2.129	—1.034	—0.669
April,	3.551	2.295	3.748	2.422	+0.197	+0.127
May,	1.927	1.246	1.876	1.212	—0.051	—0.034
June,	1.306	0.844	0.977	0.632	—0.329	—0.212
July,	0.728	0.471	0.361	0.233	—0.367	—0.238
August,	0.705	0.456	0.299	0.193	—0.406	—0.263
September,	0.651	0.421	0.321	0.208	—0.330	—0.213
October,	0.886	0.572	0.139	0.090	—0.747	—0.482
November,	1.322	0.854	0.561	0.363	—0.761	—0.491
December,	2.076	1.341	0.831	0.537	—1.245	—0.804
Average for whole year,	1.797	1.161	1.420	0.918	—0.377	—0.243

In the annual report of the State Board of Health for the year 1908 (pages 243 to 245) a table was presented giving the records of rainfall upon the Nashua River watershed and the yield expressed in inches in depth on the watershed (inches of rainfall collected) for twelve years, from 1897 to 1908, inclusive. The corresponding record for the year 1909, together with the average for the whole period of thirteen years, is given in the following table: —

Rainfall, in Inches, received and collected on the Nashua River Watershed.

Month.	For the Year 1909.			Mean for Thirteen Years, 1897-1909.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	3.52	1.056	30.0	3.64	2.134	58.5
February,	6.10	4.119	67.5	3.91	2.365	60.5
March,	4.38	3.798	86.8	4.49	4.990	111.2
April,	5.71	4.181	73.3	4.05	3.962	97.7
May,	2.65	2.162	81.6	3.53	2.222	62.9
June,	3.03	1.090	36.0	4.14	1.457	35.2
July,	4.25	0.416	9.8	4.43	0.839	19.0
August,	3.59	0.345	9.6	4.26	0.813	19.1
September,	3.90	0.358	9.2	4.01	0.727	18.1
October,	1.70	0.160	9.4	3.49	1.021	29.3
November,	1.68	0.626	37.2	3.34	1.475	44.2
December,	4.00	0.958	24.0	4.50	2.393	53.2
Year,	44.51	19.270	43.3	47.79	24.398	51.1

The following table gives the records of the yield of this watershed for each year of the past thirteen years, the flow being expressed in gallons per day per square mile of watershed: —

Yield of the Nashua River Watershed in Gallons per Day per Square Mile.[1]

Month.	1897.	1898.	1899.	1900.	1901.	1902.	1903.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000	1,265,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000	2,133,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000	3,423,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000
Average for year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000
Average for driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000

Month.	1904.	1905.	1906.	1907.	1908.	1909.	Mean for 13 Years, 1897-1909.
January,	659,000	1,266,000	1,132,000	1,458,000	1,738,000	592,000	1,196,000
February,	927,000	452,000	1,027,000	692,000	1,736,000	2,556,000	1,460,000
March,	3,008,000	3,004,000	1,860,000	1,697,000	2,192,000	2,129,000	2,798,000
April,	2,984,000	1,617,000	2,109,000	1,436,000	1,269,000	2,422,000	2,295,000
May,	1,498,000	445,000	1,533,000	965,000	1,415,000	1,212,000	1,246,000
June,	762,000	542,000	1,184,000	773,000	403,000	632,000	844,000
July,	497,000	365,000	728,000	335,000	220,000	233,000	471,000
August,	355,000	321,000	591,000	87,000	443,000	193,000	456,000
September,	494,000	1,228,000	277,000	810,000	88,000	208,000	421,000
October,	347,000	367,000	530,000	1,382,000	158,000	90,000	572,000
November,	343,000	442,000	749,000	2,540,000	125,000	363,000	854,000
December,	440,000	1,018,000	794,000	1,961,000	387,000	537,000	1,341,000
Average for whole year,	1,025,000	926,000	1,043,000	1,180,000	847,000	918,000	1,161,000
Average for driest six months,	413,000	541,000	613,000	725,000	238,000	271,000	601,000

[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6 per cent. in 1907, and to 7 per cent. in 1908 and 1909.

Merrimack River.

The flow of the Merrimack River at Lawrence has been measured for many years by the Essex Company, from whom a continuous record of the measurements made from June 1, 1887, to Jan. 1, 1910, has been obtained.

The total area of the watershed tributary at that place is 4,664 square miles, which includes at the present time 118 square miles on the South Branch of the Nashua River, 75 square miles on the Sudbury River and 19 square miles tributary to Lake Cochituate, or a combined area of 212 square miles from which water is drawn for the supply of the Metropolitan water district. The flow as measured at Lawrence includes the water wasted from these three watersheds, which, in the wet months of the year, is very considerable, but which becomes very small in the dry months. Records of the quantity of water wasted have been kept by the Boston Water Board and by the Metropolitan Water Board, and these quantities have been deducted from the flow as measured at Lawrence. The area of the three watersheds has also been deducted from the watershed area at Lawrence, so that the net area was 4,570 square miles up to March 1, 1898, at which time the Nashua River was diverted, 4,451 square miles from March 1, 1898, to Jan. 1, 1908, and 4,454 square miles in 1908 and 1909.

The average flow of the Merrimack River during the year 1909 was about 65 per cent. of the normal, making the year the driest that has occurred during the past twenty-two years for which records are available. The year next approaching this one in order of dryness was 1908, when the average flow was about 75 per cent. of the normal. In 1909 the flow was in excess of the normal in the month of February, but less than the normal in the remaining eleven months of the year. The greatest deficiency in any month occurred in March.

In order to show the relation between the flow of this stream during each month of the year 1909 and the normal flow as deduced from observations during twenty-two years, from 1888 to 1909, inclusive, the following table has been prepared: —

Table showing the Average Monthly Flow of the Merrimack River for the Year 1909 in Cubic Feet per Second per Square Mile of Drainage Area; also, the Departure from the Normal Flow.

Month.	Normal Flow. — Cubic Feet per Second per Square Mile.	Actual Flow in 1909. — Cubic Feet per Second per Square Mile.	Excess or Deficiency. — Cubic Feet per Second per Square Mile.
January,	1.507	0.677	—0.830
February,	1.485	1.563	+0.078
March,	3.051	1.695	—1.356
April,	3.858	3.404	—0.454
May,	2.390	1.951	—0.439
June,	1.326	0.948	—0.378
July,	0.754	0.447	—0.307
August,	0.674	0.376	—0.298
September,	0.737	0.369	—0.368
October,	1.004	0.422	—0.582
November,	1.295	0.388	—0.907
December,	1.415	0.504	—0.911
Average for whole year,	1.625	1.062	—0.563

Sudbury, Nashua and Merrimack Rivers.

The following table shows the weekly fluctuation during 1909 in the flow of the three streams just described, namely, the Sudbury River at Framingham, the South Branch of the Nashua River above Clinton and the Merrimack River at Lawrence. The flow of these streams, particularly that of the Sudbury and of the South Branch of the Nashua River, serves to indicate the flow of other streams in eastern Massachusetts. The area of the Sudbury River watershed is 75.2 square miles and of the South Branch of the Nashua River 118.19 square miles. The net watershed area of the Merrimack River is 4,452 square miles.

Table showing the Average Weekly Flow of the Sudbury, South Branch of the Nashua and Merrimack Rivers for the Year 1909 in Cubic Feet per Second per Square Mile of Drainage Area.

Week ending Sunday.	Flow in Cubic Feet per Second per Square Mile.			Week ending Sunday.	Flow in Cubic Feet per Second per Square Mile.		
	Sudbury River.	South Branch Nashua River.	Merrimack River.		Sudbury River.	South Branch Nashua River.	Merrimack River.
Jan. 3, . .	0.094	0.590	0.421	July 4, . .	—0.205	0.010	0.543
10, . .	1.031	1.313	0.946	11, . .	—0.405	—0.081	0.480
17, . .	0.590	0.957	0.746	18, . .	—0.050	1.009	0.422
24, . .	0.565	0.760	0.524	25, . .	0.008	0.500	0.427
31, . .	0.747	0.793	0.657	Aug. 1, . .	—0.306	0.144	0.418
Feb. 7, . .	0.867	1.116	0.592	8, . .	—0.087	0.316	0.400
14, . .	3.589	3.390	1.171	15, . .	—0.337	0.027	0.377
21, . .	4.121	4.957	1.132	22, . .	0.483	0.825	0.369
28, . .	5.783	6.358	3.353	29, . .	—0.271	0.147	0.414
Mar. 7, . .	2.192	1.965	1.762	Sept. 5, . .	—0.174	0.216	0.296
14, . .	2.189	2.425	1.314	12, . .	0.070	0.156	0.356
21, . .	1.517	1.458	1.144	19, . .	0.385	0.091	0.372
28, . .	4.194	7.110	2.181	26, . .	0.515	0.395	0.328
Apr. 4, . .	2.983	3.093	2.303	Oct. 3, . .	0.329	0.529	0.631
11, . .	1.656	2.005	3.014	10, . .	—0.432	0.063	0.449
18, . .	3.660	6.304	4.387	17, . .	—0.031	0.055	0.387
25, . .	2.527	3.642	4.087	24, . .	—0.067	0.427	0.340
May 2, . .	3.473	4.001	2.633	31, . .	—0.032	0.088	0.395
9, . .	1.713	2.112	2.498	Nov. 7, . .	0.101	0.313	0.383
16, . .	1.452	1.614	2.112	14, . .	—0.336	0.445	0.362
23, . .	1.200	1.493	1.865	21, . .	—0.247	0.466	0.329
30, . .	1.057	1.594	1.246	28, . .	1.051	0.977	0.347
June 6, . .	0.957	1.657	1.003	Dec. 5, . .	0.043	0.557	0.579
13, . .	0.841	1.461	1.161	12, . .	0.372	0.574	0.479
20, . .	0.115	0.842	0.951	19, . .	1.045	1.592	0.584
27, . .	—0.108	0.372	0.835	26, . .	0.256	0.824	0.481

EXPERIMENTS

UPON THE

PURIFICATION OF SEWAGE AND WATER

AT THE

LAWRENCE EXPERIMENT STATION.

By H. W. Clark and Stephen DeM. Gage.

Experiments upon the Purification of Sewage and Water at the Lawrence Experiment Station.[1]

By H. W. Clark and Stephen DeM. Gage.

The following report summarizes the results of the studies upon the purification of sewage during the year 1909 and upon the purification of water during the two years ending Nov. 30, 1909. In addition there is presented, as a separate paper, a complete summary of the studies made, since the station was established, upon the purification of different manufacturing wastes.

During 1909 the sand filters which have been in operation for about twenty-two years, and certain trickling and contact filters now in operation for ten and eight years, respectively, have been further investigated. A systematic study of these different filters has yielded valuable data as regards the volume of sewage which can be successfully treated year after year by filters of each type without impairment of efficiency, and as regards the methods of operation necessary to keep such filters in good working condition. The results obtained with many other filters operated for shorter periods are, furthermore, described in this report, especial attention having been devoted to determining the maximum quantities of sewage which can be treated upon a given area, and to the effect upon filters of various methods for the preliminary removal of suspended matters by which the final purification of sewage is accomplished. Sludge disposal is at present the most serious problem in the disposal of sewage on a large scale, and, as in past years, methods of disposing of sludge and also the sediment present in the effluents of contact and trickling filters have received attention. In this connection an Emscher

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[1] The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with Mr. H. W. Clark, chemist to the Board, in direct charge. Mr. Stephen DeM. Gage, biologist, and Mr. George O. Adams, chemist, are the principal assistants at the station. A full account of the work done at the Lawrence Experiment Station during the years 1888 and 1889 is contained in a special report of the State Board of Health upon the purification of sewage and water (1890). A similar account for the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports, and a review of all work at Lawrence upon sewage purification was published in the last annual report of the Board.

tank, so called, has been operated, and studies upon filters constructed of horizontal layers of slate have been resumed. These were first tried at the station in 1901, and they have been much exploited in England during the past few years.

The studies upon water filtration have included the operation of numerous slow sand and mechanical filters and of double filtration systems. Particular attention has been paid to the effect of the rate of filtration upon the efficiency of slow sand filters, and to study this point a series of filters constructed of the same depth of sand has been operated at rates varying from 2,500,000 gallons to 20,000,000 gallons per acre daily. Studies have also been made upon the removal of color from highly colored water by the use of different coagulants, followed by filtration through a mechanical filter. Filters of broken stone have been operated with water in the same manner as trickling filters with sewage, and the results obtained have aided in giving a much better comprehension of some doubtful points concerning the purification of water by biological action. An investigation upon the use of various disinfectants in connection with the purification of water and sewage has also been in progress, and the relative efficiency of many common disinfectants for this purpose has been ascertained.

Analysis of Sewage.

The sewage used at the station is pumped through a 2½-inch pipe about 4,300 feet long. The following tables present the results of the usual analyses of representative samples of sewage collected during the year. "Lawrence Street sewage" represents the average of samples collected weekly from the sewer from which the sewage is pumped; "regular sewage" represents the average of samples collected at the experiment station on at least four days each week; "sewage applied to Filters Nos. 1, 6 and 9A" represents the average of daily samples of the sewage applied to each of these filters, and is representative also of sewage applied to Filters Nos. 2, 4, 5 and 10; "Andover regular sewage" represents the average of weekly samples of the town sewage before it enters the settling tank at the Andover filtration area; by "fresh sewage" is meant an average of representative samples of all the sewage from the toilet-room at the station during one day in each week.

Lawrence Street Sewage.

[Parts per 100,000.]

Temperature (Degrees F.).	Ammonia.			Kjeldahl Nitrogen.			Nitrogen as			
		Albuminoid.								
	Free.	Total.	In Solution.	Total.	In Solution.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
61	2.39	0.91	0.52	2.75	1.83	13.12	.07	.0057	9.52	1,136,400

Regular Sewage.

44	4.02	0.68	0.34	1.26	0.62	12.81	–	–	5.67	1,369,300

Sewage applied to Filters Nos. 1, 6 and 9A.

–	4.06	0.67	–	1.20	–	11.68	–	–	5.43	–

Andover Regular Sewage.

55	3.95	0.91	0.44	1.89	0.94	8.48	–	–	6.38	1,868,400

Fresh Sewage.

58	4.90	1.89	0.72	5.63	3.04	7.28	–	–	10.00	2,849,300

Preliminary Treatments for Clarification of Sewage.

During 1909 the studies upon the clarification of sewage by the use of settling tanks and by straining through a layer of soft coal have been continued, and the large settling tank, which was installed in 1906 for the clarification of sewage to be applied to trickling and contact filters at the station, has been kept in operation. This is a cylindrical tank with a sloping bottom. The sewage enters it near the bottom and rises slowly to an outlet near the top, and has, thus, a period of sedimentation of about two hours. The accumulated sludge is removed each week. The average removal of suspended matter from the sewage during the year by this tank treatment has been about 41 per cent., as shown by albuminoid ammonia results; the total removal of organic matter has been 29 per cent. and 32 per cent., as shown by the total albuminoid ammonia and oxygen consumed results, respectively.

The work of the settling tank of the town of Andover has also been

observed as in previous years. This tank has a capacity of about 13,500 gallons; the average time required for the sewage to pass through it is approximately two hours, and the average removal of suspended matters during the year, as shown by albuminoid ammonia determinations, has been about 51 per cent. About 30 per cent. and 32 per cent. of the total organic matters, as shown by albuminoid ammonia and oxygen consumed, have been removed.

In addition to these two tanks, which receive Lawrence station sewage and Andover town sewage, respectively, a third tank has been installed in order to study the clarification of the fresh sewage from the toilet-room at the experiment station. This tank is similar to the so-called Imhoff or Emscher tank used in a number of places in Germany, and consists of a cylinder with a conical bottom sloping at an angle of 60°, inside of which is a smaller cylinder of similar design. The inner cylinder or tank is provided with a baffle plate extending about three-fourths of the way to the bottom, and has a large trapped outlet connecting it with the large tank in which it is suspended. The sewage enters at one side of the inner tank, flows under the baffle plate, rises and overflows through an outlet at the other side. The solid matters deposited in the inner tank pass downward through the trapped outlet into the large tank, where they accumulate and become decomposed by bacterial action. Owing to the trap in the outlet of the inner tank, the gases and other products of decomposition of the sludge do not mingle with the sewage during its passage through the tank. The bottom of the outer section is fitted with a gate of large size, through which the decomposed sludge may be drawn off or the whole tank emptied if desired, the flow of sludge to the outlet being facilitated by the steep slope of the conical bottom. As designed at the station, the capacity of the outer tank is equivalent to about twenty-four hours' flow of station sewage, and the capacity of the inner tank is equivalent to about five hours' flow. This tank was installed July 1, 1909, and at the end of the year, after five months' operation, sludge equivalent to about 25 cubic feet per million gallons of sewage treated — amounting to about 2.3 per cent. of the capacity of the tank — had accumulated. This tank removed during its period of operation about 86 per cent. of the suspended matters, as shown by albuminoid ammonia determinations, and about 71 per cent. of the total organic matter, as shown by both albuminoid ammonia and oxygen consumed determinations. This efficient removal of suspended matter is largely due to the fresh character of the sewage which is flushed directly from the laboratory water-closet.

Strainer E, containing 12 inches in depth of buckwheat coal, was

first put into operation in 1901. This strainer has been operated at a rate of 800,000 gallons per acre daily throughout the year, and no treatment of the surface has been required. About 61 per cent. of the suspended matter, as shown by albuminoid ammonia determinations, and about 31 per cent. of total organic matter, as shown by albuminoid ammonia, and 34 per cent., as shown by the oxygen consumed values, have been removed from the sewage in its passage through this strainer.

Analyses of the sewage as clarified by these different methods are shown in the following tables: —

Settled Sewage.

[Parts per 100,000.]

Temperature (Degrees F.).	Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.						
		Total.	In Solution.	Total.	In Solution.			
60	3.95	0.48	0.28	0.88	0.50	12.71	3.85	977,800
Andover Settled Sewage.								
55	3.74	0.64	0.41	1.40	0.92	7.56	4.35	1,313,600
Effluent of Imhoff Tank.								
57	5.98	0.55	0.38	1.38	0.99	6.24	2.87	2,704,100
Effluent of Strainer E.								
-	2.61	0.47	0.34	0.90	0.66	13.02	3.77	490,400

Sand Filters, 1/200 of an Acre in Area, Nos. 1, 2, 4, 5C, 6, 9A and 10.

At the end of 1909, Filters Nos. 1, 2, 4 and 6 had been operated nearly twenty-two years, and Filters Nos. 9A and 10 about nineteen and fifteen years, respectively. Since 1893, a period of sixteen years, these filters have been operated without sand removal.

Filter No. 1.

Filter No. 1, constructed of 60 inches in depth of sand of an effective size of 0.48 millimeter, is 1/200 of an acre in area, and was first put into operation on Jan. 10, 1888. Regular station sewage has been applied to this filter six days in a week, at a rate of 50,000 gallons per acre daily throughout the year, except during the period from July 28 to

September 8, inclusive, during which time the sewage was diluted with an equal volume of canal water. From December 1 to March 8, inclusive, the surface of the filter was trenched and the trenches were covered with boards, as described in previous reports. On March 27 the surface of the filter was leveled and dug over to a depth of 6 inches. On July 7 and again on September 26 the surface was dug over to a depth of from 6 to 12 inches, and on November 13 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter, as in previous years. The filter was rested from July 1 to 13 and from September 26 to October 3, inclusive. The portion of the surface to which sewage was applied was raked to a depth of 1 inch five times during the period when the trenches were covered with boards, and once each week during the remainder of the year.

Filter No. 2.

Filter No. 2, constructed of 60 inches in depth of fine sand of an effective size of 0.08 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Dec. 19, 1887. The surface of the filter is arranged with circular trenches 1 foot wide and 2 feet deep, of medium sand of an effective size of 0.19 millimeter, the surface of the sand being below the surface of the remainder of the filter. Regular station sewage was applied to these trenches at a rate of 40,000 gallons per acre daily throughout the year, except during the period from July 29 to September 8, inclusive, when the sewage was diluted with an equal volume of canal water. From December 1 to March 8, inclusive, the trenches were covered with boards. The sand in the trenches was dug over to a depth of from 6 to 12 inches on March 27, July 8, September 26 and November 13. The surface of the sand in the trenches was raked five times during the portion of the year when the trenches were covered with boards, and once a week during the remainder of the year. The filter was rested from July 1 to 16, from July 21 to 24 and from September 26 to October 3, inclusive. On account of high water it was out of operation from April 15 to 22, inclusive.

Filter No. 4.

Filter No. 4, constructed of 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Dec. 19, 1887. The surface of the filter is arranged with circular trenches about 14 inches wide and 12 inches deep, filled with coarse sand of an effective size of 0.48 millimeter, the surface of the sand being below that of the remainder of the filter. Regular station sewage was applied to this filter three days a week, at an average rate of 40,000 gallons per acre daily until July 27. From

July 28 to September 10, inclusive, the sewage applied consisted of equal volumes of regular station sewage and canal water, after September 10 regular station sewage being applied. The trenches were covered with boards from December 1 to March 8, inclusive. The sand in the trenches was dug over to a depth varying from 6 to 12 inches on March 27, July 8, September 26 and November 13. During the period when the trenches were covered with boards the surface of the sand in the trenches was raked to a depth of 1 inch five times, and during the remainder of the year it was so raked once each week. The filter was rested from July 1 to 16, July 21 to 28 and from September 26 to October 4, inclusive. Owing to high water it was not operated from April 9 to 12 and from April 16 to 18, inclusive.

Filter No. 5C.

Filter No. 5C, constructed of 60 inches in depth of sand of an effective size of 0.22 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on July 20, 1905. The filter was operated at a rate of 50,000 gallons per acre daily throughout the year. Sewage diluted with an equal volume of canal water was applied from July 29 to September 8, inclusive, and regular station sewage during the remainder of the year. From December 1 to March 8 the surface of the filter was trenched and the trenches covered with boards. On March 27 the surface was leveled and dug over to a depth of 12 inches. On July 6 and again on September 25 the surface was dug over to a depth of from 6 to 12 inches; on November 13 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter, as in previous years. During the period when the trenches were covered with boards the surface of the sand in the trenches was raked seven times, and during the remainder of the year the surface of the trenches, or the whole surface of the filter when it was level, was raked once each week. The filter was rested from July 1 to 14 and from September 27 to October 3, inclusive. It was out of service from April 9 to 11 and from April 15 to 22, inclusive, owing to high water.

Filter No. 6.

Filter No. 6, constructed of 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Jan. 12, 1888. The filter has been operated at a rate of 50,000 gallons per acre daily throughout the year, sewage diluted with an equal volume of canal water being applied from July 28 to September 7, inclusive, and regular station sewage during the remainder of the year. From December 1 to March 8, inclusive,

the surface of the filter was trenched and the trenches were covered with boards. On March 27 the surface of the filter was leveled and dug over to a depth of 12 inches. On July 6 and again on September 25 the surface was dug over to a depth of from 6 to 12 inches; on November 13 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter, as in previous years. During the time when the trenches were covered with boards the sand in the trenches was raked to a depth of 1 inch five times, and during the remainder of the year the surface was raked 1 inch deep each week. The filter was rested from July 1 to 14 and from September 27 to October 3, inclusive. Owing to high water it was out of service from April 8 to 11 and from April 16 to 22, inclusive.

Filter No. 9A.

Filter No. 9A, constructed of 60 inches in depth of sand of an effective size of 0.17 millimeter, is $\frac{1}{200}$ of an acre in area, and was first put into operation on Nov. 18, 1890. The filter was operated at a rate of 50,000 gallons per acre daily six days in a week throughout the year, regular station sewage being applied except during the period from July 29 to September 8, inclusive, when sewage diluted with an equal volume of canal water was applied. The surface of the filter was trenched and the trenches were covered with boards from December 1 to March 8, inclusive. On March 29 the surface of the filter was leveled and dug over to a depth of 12 inches. On July 6 and again on September 25 the surface was dug over to a depth of from 6 to 12 inches, and on November 13 the surface was dug over to a depth of 3 inches and the filter was trenched for the winter. During the period when the trenches were covered with boards the surface was raked six times, and during the remainder of the year the whole surface of the filter when it was level was raked to a depth of 1 inch each week. The filter was rested from July 1 to 15 and from September 27 to October 3, inclusive. Owing to high water it was out of service from March 27 to 28, from April 8 to 10 and from April 15 to 22, inclusive.

Filter No. 10.

Filter No. 10, $\frac{1}{200}$ of an acre in area, is constructed of 5 feet in depth of fine and coarse mixed sand of an effective size of 0.35 millimeter, and was first put into operation on July 18, 1894. There are no underdrains beneath the sand except directly above and around the outlet pipe. A partition extending 3 feet below the surface separates the quarter of the surface which is farthest from the underdrains from the remainder of the surface. To this quarter the sewage is applied, and over the

remainder of the surface is a layer of loam 8 inches in depth. Sewage was applied to this filter at a rate equivalent to 30,000 gallons per acre daily for the whole area, or 120,000 gallons per acre daily for the portion of the surface flooded six days in a week. From July 28 to September 8, inclusive, the sewage was diluted with an equal volume of canal water. During the remainder of the year regular station sewage was applied. That portion of the surface to which sewage was applied was dug over to a depth varying from 6 to 12 inches on March 29, April 12, July 6, September 25 and November 13. From December 1 to May 31 the surface was raked to a depth of 1 inch twelve times, and after June 1 it was raked once each week. The filter was rested from April 8 to May 16, from July 1 to 14, from July 21 to 26 and from September 27 to October 3, inclusive. On account of high water it was out of service from March 26 to March 29, inclusive. Early in March it was noticed that the surface of this filter had become badly clogged, and that the upper layers were filled with large numbers of earthworms, so that, during the succeeding months, frequent resting and disturbance of the surface became necessary in order to keep the filter in operating condition. Unlike the other large filters situated out of doors the surface of this filter was neither trenched nor covered with boards, but was left exposed to the weather. During January and February ice was removed from the surface six times, the total amount removed amounting to about 1 inch. Snow was removed from the surface eleven times, the total amount removed being about 27 inches.

Effluent of Filter No. 1.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.).		Length of Time Sewage remained on Surface (Minutes).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
44,500	62	56	10	0.7	.35	.7688	.0626	10.32	3.75	.0022	.72	7,600

Effluent of Filter No. 2.

34,900	62	54	16	0.0	.15	.3598	.0292	11.21	3.65	.0126	.39	450

Effluent of Filter No. 4.

17,700	62	53	6	0.0	.09	.2232	.0213	10.39	3.88	.0120	.26	110

Effluent of Filter No. 5C.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature (Deg. F.).		Length of Time Sewage remained on Surface (Minutes).	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.		Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.		
43,100	62	56	14	0.6	.30	.5617	.0531	9.90	4.16	.0017	.61	4,000

Effluent of Filter No. 6.

42,400	62	56	32	0.5	.26	.6717	.0539	10.30	3.84	.0046	.58	8,400

Effluent of Filter No. 9A.

44,200	62	56	53	0.4	.30	.3363	.0452	9.94	3.08	.0004	.59	3,200

Effluent of Filter No. 10.

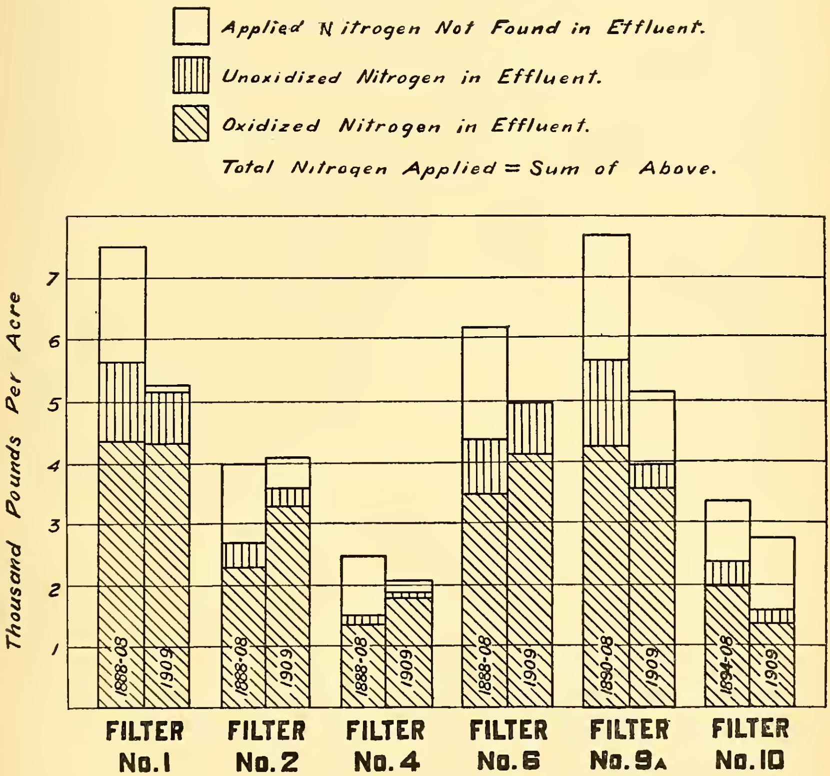
23,400	62	57	77	0.5	.25	.3228	.0482	8.72	2.33	.0008	.54	10,100

The diagram on page 289 presents graphically the average yearly amount during the period from 1888–1908, inclusive, of nitrogen applied to each of these filters, of the applied nitrogen not found in the effluent and of unoxidized nitrogen and oxidized nitrogen found in the effluent of each filter; together with the average amount of these bodies during 1909. In each instance the total height of the column represents total nitrogen.

Covering Filter Trenches with Boards and its Effect upon Temperature of Air over Surface of Filters.

As previously stated, the trenches in the surface of Filters Nos. 1, 2, 4, 5C, 6 and 9A were covered with boards during the winter. These boards with the snow which accumulated upon them protect the surfaces of the filters from the cold to about the same degree as that seen in municipal filters protected by the coatings of ice and snow which form over their surfaces. As in previous winters, frequent readings were made of the temperature of the air at the surfaces of Filters Nos. 1

and 9A, and the results are shown in a following table. The temperature of the outside air at the time readings were made varied between — 2°F. and 47°F., the average being 23°F. The temperature of the air at the surface of Filter No. 1 varied between 27°F. and 44°F. before flooding, and between 34° F. and 58° F. one hour after flooding the filter. The temperature of the air at the surface of Filter No. 9A varied between 30° F. and 40° F. before flooding, and between 34° F. and 52° F. one hour after applying sewage. In only four readings, three with Filter



No. 1 and one with Filter No. 9A, was the temperature of the air at the surface of the filters below freezing, and even on these occasions frost was not found in the sand. The comparatively small variation in the temperature under the board covers, in contrast with the wide range in the outside temperature, illustrates the value of the covering, and explains why municipal filters covered with ice and snow are able to continue to purify sewage in extremely cold weather, a matter that has been frequently noted and discussed in previous reports.

Table showing Temperature of Outside Air, of Sewage applied and of Air under Trench Covers of Filters Nos. 1 and 9A before and after Application of Sewage.

[Degrees Fahrenheit.]

Date.	Air.	Applied Sewage.	Filter No. 1.		Filter No. 9A.	
			Before Flooding.	One Hour after Flooding.	Before Flooding.	One Hour after Flooding.
1909.						
January 5,	47	55	44	58	39	47
12,	29	56	40	44	40	45
19,	—2	59	31	34	34	40
26,	28	58	35	40	35	41
February 2,	6	59	31	45	33	36
9,	9	59	27	34	30	34
16,	25	60	33	41	39	45
24,	38	60	39	49	40	52
March 3,	31	60	32	43	36	42
Average,	23	59	34	43	36	42
Maximum,	47	60	44	58	40	52
Minimum,	—2	55	27	34	30	34
Fluctuation,	49	5	17	24	10	18

Operation of Contact Filters.

During 1909 four contact filters have been in operation. Two of these, Filters Nos. 175 and 176, are constructed of coke, and have been operated for about nine years. The other two, Filters Nos. 376 and 377, are constructed of horizontal layers of slate, and were put into operation during 1909 to study further the deposition and destruction of sludge under the conditions which such filters afford. Filters similar in construction and operation were studied at the station in 1901 and 1902, as described in the reports for those years and reviewed in the report for 1908, and filters of the same general type are in use in a few places in England.

Filters Nos. 175 and 176, first put into operation June 3, 1901, were continued during 1909. Each filter is 5 feet in depth and is constructed of pieces of coke of such size that all will pass through a sieve having a 1-inch mesh, 75 per cent. through a ½-inch mesh and practically none through a sieve with a ¼-inch mesh. Filter No. 175 has always received sewage that has passed through a coke or coal strainer, and Filter No.

176 has received settled sewage throughout the year. Each of these filters has been filled once daily in one dose, allowed to stand full two hours before draining, and each has been allowed to rest every sixth week. During the year Filter No. 175 was operated at an average rate of 415,500 gallons per acre daily, and Filter No. 176 at an average rate of 270,000 gallons per acre daily. During 1909 no reduction in open space occurred in Filter No. 175, and the effluent continued to be of the same general quality as in preceding years. Filter No. 176 lost about 11 per cent. of its open space during the year. This filter is badly clogged with organic matter, and the effluent during the greater part of the year has been of poor quality and discolored with iron, showing a reducing action within the filter. The regeneration of this filter by resting and by allowing it to stand filled with sewage for varying periods has been tried with but little success, and it is evident that the material must be removed and washed if the filter is to be continued in operation.

Filters Nos. 376 and 377. — These two filters, first put into operation on July 9, 1909, are constructed of layers of roofing slate placed horizontally, the layers of slate being separated from one another by small concrete blocks three-fourths of an inch thick. Filter No. 376 has a superficial area of about $1/_{4200}$ of an acre, and contains twenty-seven layers of slate, the exposed surface available for the deposition of sludge being about 314 square inches for each gallon of sewage held by the filter when completely flooded. Filter No. 377 has a superficial area of about $1/_{6500}$ of an acre, and contains eight layers of slate, the area available for the deposition of sludge amounting to about 187 square inches per gallon of sewage. Both filters are so arranged that the layers of slate can be cleaned by flushing with a hose when necessary. Filter No. 376 has received regular station sewage and Filter No. 377 has received the fresh supernatant sewage from the Imhoff tank. Both filters are operated as contact filters, being filled in one dose applied daily and drained slowly after a contact period of two hours. Both filters have been operated six days a week without systematic resting, and no removal of sludge from the filter plates has been made during the five months they have been operated. Filter No. 376 has lost about 8 per cent. and Filter No. 377 about 3 per cent. of open space during this period. From the following tables it will be observed that there has been practically no nitrification within either filter, and this was not to be expected. These so-called filters are simply contrivances to remove, and, if possible, destroy sludge by biological action.

Average Chemical Analyses.

Sewage applied to Contact Filter No. 376.

[Parts per 100,000.]

Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen Consumed.
Free.	Albuminoid. Total.	Albuminoid. In Solution.	Total.	In Solution.		
2.63	.42	.25	.73	.44	9.67	3.25

Sewage applied to Contact Filter No. 377.

6.25	.69	.54	1.26	.94	7.62	4.46

Average Chemical Analyses of Effluents of Contact Filters.

Effluent of Filter No. 175.

[Parts per 100,000.]

Quantity Applied. Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
415,500	–	4.2	.68	.8698	.2670	.2058	.4990	12.06	1.96	.0214	2.07	480,600

Effluent of Filter No. 176.

270,000	60	2.7	.92	1.1545	.1644	.1108	.3004	12.73	0.14	.0015	1.64	134,100

Effluent of Filter No. 376.[1]

646,000	–	5.1	.86	2.3650	.3140	.2200	.5414	9.41	0.05	.0018	2.25	516,300

Effluent of Filter No. 377.[1]

222,700	–	6.0	1.85	6.3450	.6730	.5006	1.2635	7.65	0.13	.0092	4.05	1,793,800

[1] Filters started July 9, 1909.

Trickling Filters Nos. 135, 136, 222, 248, 360, 361 and 362.

During 1909, seven trickling filters have been operated, six at the experiment station and one at the Andover filtration area. Of the six filters at the station, five were constructed of broken stone and one of

clinker. Two of the broken-stone filters, Nos. 135 and 136, have been in operation for over ten years. With three of the other filters the effect of different sizes and characters of material, of different depths of filtering material, and of the uniform and uneven distribution of the sewage upon the surface have been studied comparatively.

Filters Nos. 135 and 136, $1/20000$ of an acre in area, are constructed of 10 feet in depth of broken stone, all of which will pass through a screen with a 1-inch mesh, 40 per cent. through a screen with a $1/2$-inch mesh and 4 per cent. through a screen with a $1/4$-inch mesh. These filters were first put into operation in November, 1899. Settled sewage has been applied to the surface of these filters throughout the year by means of automatic tipping basins placed in perforated pans, in the same manner as with other trickling filters at the station. From Dec. 1, 1908, to March 1, 1909, Filter No. 135 was operated at a rate of 1,500,000 gallons per acre daily, and Filter No. 136 at a rate of 6,000,000 gallons per acre daily. From March 3 to April 30 both filters were operated at a rate of 3,000,000 gallons per acre daily; from May 1 to the end of the year they were operated at a rate of 2,000,000 gallons per acre daily. On April 2 the surfaces of both filters had become somewhat clogged, with the result that pooling of sewage upon the surface occurred, and each filter was dug over to a depth of about 3 inches.

Filter No. 248, $1/20000$ of an acre in area, and constructed of 8 feet in depth of material of the same grade as that in Filters Nos. 135 and 136, was first put into operation on May 16, 1904. Settled sewage has been applied to this filter throughout the year at a rate of 2,000,000 gallons per acre daily. On April 2 the surface of the filter was dug over to a depth of about 3 inches.

The average analyses of the effluents from Filters Nos. 135, 136 and 248 are shown on page 298.

Filter No. 222. — Studies upon Distribution.

Filter No. 222, $1/200$ of an acre in area, and containing about 7 feet in depth of pieces of broken stone having a mean diameter of between 1 and 2 inches, is located at Andover. Andover settled sewage has been applied to this filter throughout the year. Previous to April 15 the distribution of sewage over the surface of the filter was accomplished by means of an automatic flush tank and dashplates, as described on page 268 of the report for 1906, but after April 21 distribution of the sewage took place by means of a traveling distributor of the Fiddian type. This distributor is in effect a long overshot water-wheel, actuated by the flow of sewage into a series of shallow tapering buckets fastened to the periphery of a cylinder about 8 feet long and 18 inches in

diameter. This cylinder is carried on a shaft which is supported at one end by a pivot-bearing at the center of the filter, and at the other end by a wheel which travels upon a circular track around the outside of the filter. A universal joint at the junction of the shaft and central pivot permits adjustment and prevents any binding in the bearings due to inequalities in the track. Both the pivot and the shaft are carried on ball bearings. The sewage flows into a hopper carried upon the central pivot, and thence through a shallow trough which travels with the distributor and is discharged through a number of openings into the buckets upon the periphery of the cylinder, from which it is discharged upon the surface of the filter as the cylinder turns. If the taper of the buckets be properly designed, a perfectly even distribution of sewage upon all parts of the filter surface over which the apparatus travels should result. In practice, however, small irregularities in the metal work of the apparatus, and slight unevenness in the track, the elimination of which would make the construction of the apparatus unnecessarily expensive, have prevented absolute uniformity of distribution. Notwithstanding these defects, however, the distribution upon the filter has been much more uniform than with any of the devices previously tried.

Many measurements have been made of the uniformity of distribution upon this filter by the dashplate system and by the rotary distributor. In general, the results of such measurements show that with the dashplate system only about 17 per cent. of the filter surface receives sewage at approximately the intended rate, that is, at a rate of between 1,000,000 and 2,000,000 gallons per acre daily; that about 24 per cent. of the surface does not receive any sewage; that about 23 per cent. of the surface receives only about half the intended amount of sewage, while about 20 per cent. of the surface of the filter is being flooded at rates of from 2,000,000 to 4,000,000 gallons per acre daily, and about 16 per cent. of the surface is receiving sewage at rates of from 4,000,000 to 7,500,000 gallons per acre daily. With the rotary distributor about half of the surface receives sewage at approximately the intended rate; about one-fourth of the surface receives sewage at rates of from 250,000 to 1,000,000 gallons per acre daily, and about one-fourth of the surface receives sewage at rates from 2,000,000 to 3,250,000 gallons per acre daily. With this distribution, a small area at the center, occupied by the pivot and shaft bearings, amounting to less than 1 per cent. of the surface, was not flooded. A typical series of distribution measurements by each of these two systems is shown in the following table: —

Table showing Rates at which Sewage was applied to Different Portions of Surface of Filter No. 222 by Dashplate and Rotary Distributors.

Rate (Million Gallons per Acre Daily).	Per Cent. of Surface.		Rate (Million Gallons per Acre Daily).	Per Cent. of Surface.	
	Dashplate Distribution.	Rotary Distributor.		Dashplate Distribution.	Rotary Distributor.
Not wet, . . .	24.1	0.7	Between 2.5 and 3.5, .	11.1	8.8
Less than 0.5, . .	21.3	3.6	Between 3.5 and 4.5, .	7.2	0.0
Between 0.5 and 1.5, .	13.1	48.6	Between 4.5 and 6.0, .	7.9	0.0
Between 1.5 and 2.5, .	12.7	38.3	Between 6.0 and 7.5, .	2.7	0.0

Net rate on whole area (million gallons per acre daily): Dashplate distribution, 1.6; rotary distributor, 1.5.

From Dec. 1, 1908, to April 16, 1909, Andover settled sewage was applied to Filter No. 222, by means of the automatic flush tank and dashplates, at intervals of about seven minutes throughout the whole twenty-four hours, the average rate of the filter during this period being 1,540,000 gallons per acre daily. From April 28, when the rotary distributor was installed, until June 20, settled sewage was applied continuously throughout the twenty-four hours, at a rate of 1,500,000 gallons per acre daily. From June 21 to September 22 the filter was allowed to rest six hours during the middle of the day, the whole of the sewage, equivalent to a net rate of 1,500,000 gallons per twenty-four hours, being applied in eighteen hours. On September 23 the rate and method of operation of the filter were changed, sewage equivalent to 1,000,000 gallons per acre daily being applied during twelve hours and the filter being allowed to rest the remaining twelve hours. Very little trouble was experienced in the operation of the filter by the dashplate system during the winter months, the weather being somewhat less severe than during preceding winters.

Clogging of Filter No. 222. — Use of Disinfectants.

On January 12 some pooling was noticed on the surface, and the filter was raked to a depth of from 1 to 2 inches. Early in May pooling was again observed, and an examination showed that the surface layers were clogged in part with organic matter, but largely by the larvæ of small flies (*psychoda alternata*), whose presence about trickling filters has been noted in previous reports. The larvæ of these flies collect in enormous numbers in the upper layers of the filtering material, completely clogging the filter. At times as a result, the sewage stands in

pools on the surface, and proper ventilation is largely cut off. The flies themselves, in addition to annoying the filter attendants, are feeble of flight, and die in large numbers upon the surface of the filter, thus adding to the clogging. Attempts were made to control this nuisance on Filter No. 222 by the use of disinfectants. During the summer, copper sulphate in the proportion of 830 pounds per million gallons was mixed with the applied sewage on four different occasions, and bleaching powder in the same proportion was used on another occasion. The copper sulphate was somewhat more effective than the bleaching powder, but the results with either were not entirely satisfactory, and it was necessary to dig over the surface of the filter to a depth of from 3 to 4 inches on May 19, and again on September 2, to permit the sewage to pass into the filter. On October 6 the fly nuisance had practically ceased, but the upper layers of the filter were still badly clogged. On this date caustic soda, equivalent to about 1,000 pounds per acre, was scattered over the surface to break up and destroy the clogging material. After this treatment the effluent from the filter was heavily charged with organic matter for some time, and examinations of the surface layers showed that the clogging material had been eliminated to a considerable extent. The sewage applied to this filter is very strong, containing a considerable amount of suspended matters. Experiments in previous years have shown that not only is this sewage more difficult to purify than that applied to the filters at the experiment station, but that growths of slime moulds, bacterial zoöglea and other fungi are likely to develop upon or within filters to which it is applied. The flies, however, were undoubtedly one of the contributory causes of the clogging of this filter, as has been the case with the trickling filters at the experiment station and elsewhere.

Better Nitrification due to Better Distribution.

Notwithstanding the difficulty of keeping the surface of this filter open, the effluent during the past summer has been more highly nitrified and of better quality generally than during any previous summer, and this can be attributed only to the more uniform distribution of the sewage upon the surface of the filter by the rotary distributor, and to the resulting equalization of the amount and character of the work performed in different portions of the bed. The increase in the nitrates during May and June, immediately following the installation of this distributor, was especially marked.

Filters Nos. 360, 361, and 362. — These filters, each $\frac{1}{10000}$ of an acre in area and containing 8 feet 9 inches in depth of material held in place by open cob-work sides, were started Nov. 14, 1908. Filters Nos.

360 and 361 were constructed of pieces of broken stone having a mean diameter of between 1 and 2 inches, and Filter No. 362 was filled with pieces of hard clinker having a mean diameter of from 4 to 6 inches. All of these filters had underdrain channels open at each end in order that any sediment might be readily flushed out. Small, half-round drains were placed in the material in Filter No. 361 at different levels, from which samples were collected regularly to show the amount of purification of the sewage after it had passed through 2, 4, 6 and 8 feet 9 inches of filtering material, respectively.

Settled sewage was applied to each of these filters at a rate of about 1,500,000 gallons per acre daily throughout the year and was distributed over the surface by means of automatic tipping basins placed in perforated pans, the distribution upon Filters Nos. 361 and 362 being practically uniform over the whole surface. The distribution of sewage upon the surface of Filter No. 360 was so arranged that while the net rate upon the entire area was the same as on Filters Nos. 361 and 362, the sewage was applied at different rates to different parts of the surface, as is seen in trickling filters upon which the distribution is accomplished by means of fixed dashplates or upward-flow nozzles. By special construction of the distributing pan, the rate at which sewage was applied was gradually increased from one side of the filter to the other. Frequent measurements were made of the rate at which the sewage was being applied to each of the three sections of this filter. These measurements varied somewhat from time to time, but the average during the year showed that with an average net rate upon the whole area of about 1,330,000 gallons per acre daily, the average rate upon Section A was about 2,200,000 gallons, upon Section B about 1,080,000 gallons, and upon Section C about 700,000 gallons per acre daily.

The underdrain system of this filter was divided into three distinct sections, corresponding with the three sections of the surface as divided by the spreader pan, and separate samples were collected from each section. Owing to the open construction of the filter walls, a certain amount of sewage found its way down the outside of the filter and was not collected by the underdrain system, and for this reason the rates of the three outlets never agreed with the rates at which the sewage was applied to the corresponding portions of the surface. In addition, some clogging occurred at the surface and at some parts of the open sides, due in part to growths of the larvæ of small flies, which destroyed the effectiveness of the graded distribution. Attempts to prevent the growth of these larvæ by the use of copper sulphate in the applied sewage were only partially successful. The effect of these flies on the operation of trickling filters is discussed under the operation

of Filter No. 222. Another result of the open construction was that a greater amount of filtering material was exposed to the air in two of the sections than in the middle section. The effect of this was particularly noticeable in the heavy growth at times of zoöglea, which formed upon the stones and sides of the tank which were wet with sewage and exposed to the air. Fly larvæ, moreover, developed in large numbers, and this growth was heaviest at the sides of the filter most exposed to the light. While the operation of this filter was not entirely successful in showing the effect of unequal distribution, owing to the mechanical and operating difficulties mentioned, the analyses of the effluents from the different sections and of the average effluent from the whole filter show how the general effluent from a trickling filter may be composed of a number of effluents differing widely in character, according to the portion of the filter from which they come.

The average analyses of the effluents from these various trickling filters and from the different parts of Filters Nos. 360 and 361 are shown in the following tables. The analyses of samples after passage of the sewage through 2, 4, 6 and 8 feet 9 inches of material, respectively, in Filter No. 361 are particularly interesting, showing as they do a progressing nitrification and confirming admirably the experiments made with Filter No. 131 in 1899 and 1900.

Average Chemical Analyses of Effluents of Trickling Filters.

Effluent of Filter No. 135.

[Parts per 100,000.]

Quantity Applied. Gallons per Acre Daily.	Sewage Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
1,973,100	60	2.4	.63	1.0266	.3205	.1800	.5381	12.24	2.57	.0167	2.35	51,300

Effluent of Filter No. 136.

3,019,100	60	3.5	.71	1.7056	.3341	.2217	.5993	12.40	1.56	.0071	2.76	76,900

Effluent of Filter No. 222.

–	54	–	.55	2.1661	.4458	.2267	.8496	7.25	0.81	.0162	2.54	347,300

Effluent of Filter No. 248.

1,959,000	60	3.3	.66	1.1646	.5915	.2318	1.0066	12.04	2.33	.0136	3.80	150,300

Average Chemical Analyses of Effluents of Trickling Filters — Concluded.

Effluent of Filter No. 360 (Section A).

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Sewage Temperature (Degrees F.).	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.			Nitrates.	Nitrites.		
2,200,000	50	6.5	.80	2.3313	.4277	.2633	0.7420	12.51	0.84	.0555	3.00	507,000
Effluent of Filter No. 360 (Section B).												
1,080,000	52	5.5	.81	1.8208	.3763	.2260	0.6691	12.46	1.55	.0392	2.79	387,700
Effluent of Filter No. 360 (Section C).												
700,000	52	5.8	.82	2.0354	.3785	.2439	0.6706	12.45	1.42	.0417	2.83	417,000
Effluent of Filter No. 360 (Entire Filter).												
1,330,000	51	6.2	.81	2.1000	.4079	.2525	0.7122	12.49	1.10	.0496	2.92	465,700
Effluent of Filter No. 361 (Two Feet).[1]												
-	-	5.5	.85	3.0305	.5186	.3701	0.8525	13.29	0.31	.0507	3.16	524,200
Effluent of Filter No. 361 (Four Feet).[1]												
-	-	5.5	.84	2.6750	.5536	.3464	0.9694	13.31	0.71	.0633	3.41	491,300
Effluent of Filter No. 361 (Six Feet).[1]												
-	-	5.4	.84	2.4500	.6517	.3604	1.1651	13.34	0.96	.0890	3.81	461,300
Effluent of Filter No. 361 (Outlet).												
1,335,200	51	6.1	.84	2.2458	.4706	.2678	0.8348	12.45	1.03	.0612	3.41	469,300
Effluent of Filter No. 362.												
1,333,700	51	5.3	.81	2.0931	.3521	.2348	0.6341	12.48	1.09	.0343	2.89	403,300

[1] Average for nine months, March to November, inclusive.

Refiltration of Effluents from Trickling Filters. — Filters Nos. 363 and 371.

Filter No. 363, 1/20000 of an acre in area, is constructed of 4½ feet in depth of pea-size metallurgical coke, and was first put into operation on Nov. 18, 1908. This filter has been operated as a trickling filter, receiving the effluents from Filters Nos. 135 and 136 after being passed through a settling basin. Until March 3, 1909, the effluent from Filter No. 136 was applied to this filter; after that date the combined effluents from Filters Nos. 135 and 136 were applied. From Dec. 1, 1908, until April 30, 1909, the rate of operation was 6,000,000 gallons per acre daily. On May 1, 1909, the rate was reduced to 4,000,000 gallons per acre daily, at which rate the filter was operated during the remainder of the year. The effluent from this filter has been stable from the start, and the nitrification so well begun in the primary filters has been continued in the secondary filter.

Filter No. 371, 1/80000 of an acre in area, and constructed of 2 feet in depth of sand of an effective size of 0.23 millimeter, was first put into operation on May 20, 1909. This filter has been operated continuously in much the same manner as continuous water filters, except that when clogged instead of scraping or surface washing, the whole body of sand in the filter has been washed in place by an upward current of water from below. The effluent from Filter No. 362, after passing through a settling basin with a capacity of eleven hours' flow, was applied to Filter No. 371 at a rate of 5,000,000 gallons per acre daily until June 30, 1909. After July 1 the combined effluents from Filters Nos. 361 and 362 were passed through the settling tank and applied to this filter, which was operated at a rate of 10,000,000 gallons per acre daily, the increase in the rate reducing the time of sedimentation to about five and one-fourth hours. From May 20 to June 30, while being operated at a rate of 5,000,000 gallons per acre daily, the filter was washed four times, the average quantity of water filtered between washings being about 17,000,000 gallons per acre. From July 1 to November 30, with a rate of 10,000,000 gallons per acre daily, it was necessary to wash the filter twenty times, the average volume of water filtered between washings being about 23,000,000 gallons per acre.

The average analyses of the settled effluents from the primary filters and of the effluents from these two secondary filters are shown in the following tables: —

Average Chemical Analyses. — Secondary Filters.

Applied for Filter No. 363.[1]

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Kjeldahl Nitrogen.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
-	62	2.3	.65	1.4891	.1629	.1284	0.3516	12.51	1.77	.0386	1.47	87,400
Effluent of Filter No. 363.												
4,609,800	59	1.7	.58	0.8733	.1265	.1014	0.2750	11.45	2.18	.0123	1.26	17,000
Applied for Filter No. 371.												
-	64	2.3	.74	1.9224	.1962	.1485	-	13.69	1.27	.0886	1.58	1,003,500
Effluent of Filter No. 371.[2]												
7,059,000	64	0.7	.68	1.7800	.1233	-	-	13.38	1.15	.0615	1.20	771,600

[1] March to November inclusive. [2] Filter No. 371 started May 20, 1909.

Removal of Bacteria by Filters of Various Types.

In the following table are shown the average numbers of bacteria, as determined on agar plates, incubated four days at 20° C.; also the total number of colonies and the number of red colonies on litmus lactose agar plates incubated eighteen hours at 40° C. The significance of these different counts has been discussed frequently in preceding reports. All of the intermittent sand filters show a removal of over 99 per cent. of all types of bacteria, as is usual with such filters when properly operated. Of the four contact filters operated, Filter No. 176, which was badly clogged and in which nitrification was feeble during the year, showed a bacterial removal of over 86 per cent., while its companion filter, which was in good condition, showed practically no removal of 20° bacteria and a removal of only about 30 per cent. of the 40° bacteria. Of the two slate filters, the one operated with Lawrence regular sewage showed a bacterial efficiency of 60 to 70 per cent., while the one operated with settled fresh sewage showed a removal of about one-third of the total bacteria, but no removal of the types of

bacteria determined at 40° C. The removal of bacteria by the older trickling filters, Nos. 135, 136 and 248, was much greater than that by the other trickling filters at the station, which latter were constructed of coarser material and had been operated for only a short time. The work of Filter No. 135, with a removal of 97 per cent. of all types of bacteria, was particularly satisfactory. The progressive removal of bacteria from the sewage as it passes through a trickling filter is well illustrated by samples collected from different depths in Filter No. 361. The apparent falling off in efficiency between the 6-foot level and the bottom of this filter is due to the fact that collection of samples from the various depths was not begun until nitrification had become thoroughly established, whereas samples from the outlet were collected from the time the filter was started. Of the two secondary filters, Filter No. 363, constructed of pea-size coke and operated as a trickling filter, was much more efficient in removing bacteria than Filter No. 371, which was constructed of sand and operated in the same manner as water filters are operated. Of particular interest is the work of the Imhoff tank, in which the fresh sewage was clarified. Judging by the total counts at 20° C. the removal of bacteria by this tank was very slight. The removal of over 98 per cent. of the 40° bacteria, however, is an extremely satisfactory result, and it is to be emphasized particularly that it is the elimination of these types of bacteria which is most important from a hygienic standpoint.

Table showing Removal of 20° and 40° C. Bacteria by Sewage Filters.

	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.		
	20° C.	40° C.		20° C.	40° C.	
		Total.	Red.		Total.	Red.
Lawrence street sewage,	1,136,400	293,900	236,900	-	-	-
Regular sewage,	1,374,400	373,200	315,800	-	-	-
Settled sewage,	979,400	163,100	131,800	28.70	56.30	58.30
Effluent, Strainer E,	490,400	130,800	84,600	64.20	65.00	73.20
Andover regular sewage,	1,810,600	343,900	269,300	-	-	-
Andover settled sewage,	1,293,600	243,300	197,300	28.70	29.30	26.70
Fresh sewage,	2,849,300	640,700	583,300	-	-	-
Effluent, Imhoff tank,	2,704,100	12,100	7,900	5.20	98.10	98.60
Effluent, sand filter: —						
No. 1,	7,600	3,450	2,800	99.45	99.08	99.11
2,	450	6	4	99.97	99.99	99.99
4,	110	17	13	99.99	99.99	99.99
5C,	4,300	2,000	1,500	99.69	99.46	99.53
6,	8,400	4,000	3,200	99.39	98.93	98.99
9A,	3,800	350	250	99.72	99.91	99.92
10,	8,500	290	210	99.38	99.92	99.93

Table showing Removal of 20° and 40° C. Bacteria by Sewage Filters — Concluded.

	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.		
	20° C.	40° C.		20°.	40° C.	
		Total.	Red.		Total.	Red.
Effluent, contact filter: —						
No. 175,	486,100	90,800	66,800	0.80	30.70	21.00
176,	134,100	21,500	16,300	86.30	86.80	87.70
376,	516,300	151,300	93,800	62.30	59.60	70.40
377,	1,793,800	103,100	98,100	33.70	-	-
Effluent, trickling filter: —						
No. 135,	51,300	5,150	4,000	96.80	96.90	97.00
136,	78,200	57,100	41,600	92.10	65.10	68.40
222,	352,900	30,500	22,100	72.60	87.40	88.80
248,	152,400	22,000	19,100	84.50	86.50	85.50
360A,	506,100	65,600	48,200	48.50	59.80	63.40
360B,	387,700	31,500	24,800	60.80	80.70	81.20
360C,	417,000	35,000	27,400	57.50	78.50	79.20
360 (entire),	465,700	52,600	39,300	52.50	67.70	70.20
361 (2 feet),	524,200	61,900	47,500	46.70	62.00	63.90
361 (4 feet),	491,300	42,400	28,200	49.80	74.00	78.60
361 (6 feet),	461,300	34,800	22,300	53.00	78.60	83.10
361 (outlet),	469,400	29,500	20,100	52.20	81.80	84.80
362,	403,300	26,700	20,100	58.80	83.70	84.80
Secondary filter: —						
No. 363,	17,000	3,200	2,000	80.60	77.00	44.40
371,	773,700	22,900	8,500	22.60	36.00	63.10

Purification of Water during 1908 and 1909.

During 1908 and 1909 studies on the purification of polluted water by slow sand filtration, by double filtration, and by slow sand and mechanical filters with the aid of coagulants, have been continued. Systematic studies have been carried on concerning the relative efficiency of filters of equal depths and containing sand of the same effective size, but operated at differing rates, and of the effect of the use of calcium hypochlorite and other disinfectants in connection with water filtration. Tests have been made of a system of upward filtration, and also some experiments with filters constructed of broken stone and operated in a manner similar to trickling filters used in sewage purification. As in previous years, special attention has been paid to the work of the filters which purify the water supply of the city of Lawrence.

Lawrence City Filters.

The water supply of the city of Lawrence is purified by two slow sand filters. The older filter was constructed in 1893. Walls dividing it into three sections were built in 1902. The average depth of sand in this filter is about 4 feet, and the net filtering area, after deducting division walls, gate-chambers and lateral carriers, is about 2.2 acres. As originally constructed, this filter contained two different grades of sand, the filter immediately over the underdrains being composed of finer sand than the remainder of the filter. By reason of scraping, washing and replacing sand during seventeen years, the two grades of sand have become quite thoroughly mixed in the upper layers of the filter, and at the present time this upper sand has an effective size of approximately 0.25 millimeter. This filter is not covered and has an earth and hardpan bottom through which some ground water finds its way into the underdrains, mingling finally with the filtered water. The average rate of operation of this filter during the past two years has been about 1,250,000 gallons per acre daily.

During 1906 and 1907 an additional filter was constructed. This filter is of concrete construction, has a tight bottom, is covered by a groined arch roof, is three-fourths of an acre in area and contains about 4.5 feet of sand of an effective size of 0.25 millimeter. It was first put

into operation on Nov. 4, 1907, but the filtered water was not turned into the pump-well until Jan. 4, 1908. The rate of operation was at first 1,000,000 gallons per acre daily, but this rate was gradually increased during January and February, 1908, to 3,000,000 gallons per acre daily, at which rate the filter has since been operated. The effluents from both filters flow into the same pump-well, from which they are pumped into the distributing reservoir. In the accompanying tables are shown analyses of the Merrimack River as it flows to the filters, of the effluents from both filters, and of the mixed effluents, not only as pumped into the distributing reservoir but also as distributed to various points after passage through that reservoir.

Comparing the results obtained with these two filters during the past two years, it will be noted that the new filter operated at a rate somewhat more than twice as great as that of the old, produced an effluent during 1908 of about the same chemical quality as that of the old filter, with two exceptions, — nitrification was somewhat less marked and there was present only slightly more than one-half as much iron. During 1909 the effluent of the new filter contained considerably less coloring matter, less free ammonia and only about one-third as much iron as the effluent of the old filter, the difference being due to the ground water that enters the underdrains of the old filter and is there mixed with the filtered water. As noted in previous years, the chemical character of the filtered water improved materially as it passed through the reservoir and distributing system of the city.

The bacterial efficiency of the old filter during both years was greater than that of the new filter, this superiority being due in part to the much lower rate of operation of the old filter and in part to the fact that this filter has become thoroughly matured by many years of operation. The efficiency of both filters, however, was quite satisfactory. The average bacterial content of the Merrimack River water applied to these filters during 1908 was 6,500 per cubic centimeter. The effluent of the old filter contained on an average 90 bacteria per cubic centimeter, and the effluent of the new filter 120 bacteria per cubic centimeter, giving bacterial efficiencies of 98.6 and 98.2 per cent., respectively. During 1909 the river water averaged 7,400 bacteria per cubic centimeter, the effluent of the old filter, 60 bacteria per cubic centimeter and the effluent of the new filter 100 bacteria per cubic centimeter, giving bacterial efficiencies of 99.2 and 98.7 per cent., respectively. During both years the B. coli efficiency of the old filter, operated at the lower rate, was considerably greater than that of the new filter.

Average Chemical Analyses.

Merrimack River. — Intake of the Lawrence City Filter.

[Parts per 100,000.]

Year.	Temperature (Degrees F.).	Appearance.		Ammonia.			Chlorine.	Nitrogen as —		Oxygen Consumed.	Iron.	Hardness.
		Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.			
1908, . . .	53	0.2	.40	.0142	.0200	.0167	.40	.012	.0004	.53	.0640	1.0
1909, . . .	52	0.3	.36	.0193	.0248	.0208	.45	.014	.0005	.63	.0739	1.1

Effluent of the Lawrence City Filter (Old Filter).

1908, . . .	54	0.1	.31	.0096	.0094	–	.42	.028	.0003	.36	.0912	1.4
1909, . . .	52	0.0	.32	.0131	.0103	–	.47	.034	.0002	.44	.1203	1.6

Effluent of the Lawrence City Filter (New Filter).

1908, . . .	54	0.1	.31	.0061	.0101	–	.41	.023	.0007	.37	.0520	1.6
1909, . . .	52	0.0	.27	.0096	.0126	–	.45	.025	.0002	.50	.0397	1.3

Water from the Outlet of the Distributing Reservoir.

1908, . . .	54	0.1	.33	.0051	.0084	–	.42	.037	.0002	.34	.0714	1.4
1909, . . .	51	0.0	.33	.0070	.0114	–	.48	.033	.0002	.43	.0896	1.4

Water from a Tap at Lawrence City Hall.

1908, . . .	54	0.1	.34	.0034	.0081	–	.42	.036	.0001	.30	–	1.3
1909, . . .	52	0.0	.37	.0056	.0110	–	.48	.035	.0002	.43	–	1.4

Water from a Tap at the Lawrence Experiment Station.

1908, . . .	55	0.1	.33	.0027	.0075	–	.41	.036	.0001	.31	–	1.4
1909, . . .	53	0.1	.32	.0041	.0099	–	.49	.036	.0001	.42	–	1.4

Average Bacterial Analyses.

Year.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.	
	20° C.	40° C.		20° C.	40° C.			
		Total.	Red.		Total.	Red.	1 c. c.	100 c. c.
Merrimack River. — Intake of the Lawrence City Filter.								
1908, . . .	6,500	100	62	-	-	-	100.0	100.0
1909, . . .	7,400	180	100	-	-	-	100.0	100.0
Effluent of the Lawrence City Filter (Old Filter).								
1908, . . .	90	23	17	98.6	77.0	72.6	17.4	63.0
1909, . . .	60	7	3	99.2	96.1	97.0	8.6	50.7
Effluent of the Lawrence City Filter (New Filter).								
1908, . . .	120	10	4	98.2	90.0	93.5	30.8	79.9
1909, . . .	100	9	3	98.7	95.0	97.0	17.1	56.9
Mixed Effluents as pumped to Distributing Reservoir.								
1908, . . .	130	47	41	-	-	-	18.6	66.0
1909, . . .	80	6	2	-	-	-	9.4	57.4
Water from the Outlet of the Distributing Reservoir.								
1908, . . .	48	11	7	-	-	-	12.1	65.1
1909, . . .	32	5	1	-	-	-	4.2	55.7
Water from a Tap at Lawrence City Hall.								
1908, . . .	38	5	2	-	-	-	5.0	58.5
1909, . . .	32	4	1	-	-	-	0.0	42.5
Water from a Tap at the Lawrence Experiment Station.								
1908, . . .	39	5	2	-	-	-	7.6	59.6
1909, . . .	27	5	1	-	-	-	3.3	54.5

Slow Sand Filters.

Filters Nos. 8A and 343.

Filter No. 8A, $\frac{1}{200}$ of an acre in area, and first put into operation on Sept. 26, 1893, contained about 38 inches in depth of sand of an effective size of 0.28 millimeter at the beginning of 1908. This filter was operated throughout 1908 and 1909 at a rate of about 3,000,000 gallons per acre daily. It was scraped eighteen times during the two years, and on May 29, 1908, the filter was dug over to a depth of 18 inches to loosen the sand, which had become compacted during the construction of a new roof. The average amount of water filtered between scrapings was about 84,000,000 gallons per acre.

Filter No. 343, $\frac{1}{20000}$ of an acre in area, containing 40 inches in depth of sand of an effective size of 0.35 millimeter, was started March 27, 1908, and has been operated since that time at a rate of 5,000,000 gallons per acre daily. The surface of the filter has been washed forty-three times during the twenty months it has been in operation, the average amount of water filtered between washings being about 62,000,000 gallons per acre.

Analyses of the canal water applied to these filters are given on page 323, and the average chemical and bacterial analyses of their effluents are shown in the following tables.

Comparing the work of these two filters it will be observed that chemically their effluents were quite similar. The effluent from the older filter, however, No. 8A, was of much better bacterial quality than the effluent from Filter No. 343, which was started in 1908, and which was operated at a much higher rate. The average number of bacteria in the effluent of Filter No. 8A was 90 per cubic centimeter during 1908 and 48 per cubic centimeter during 1909, representing a bacterial efficiency in each year of over 99 per cent. The average number of bacteria in the effluent from Filter No. 343, omitting the first month, during which the filter was coming to maturity, was 236 in 1908 and 85 in 1909, corresponding to bacterial efficiencies of 95.9 and 98.4 per cent., respectively. Furthermore, B. coli were found in one cubic centimeter in about one-fourth of the samples of the effluent from Filter No. 343 during both years, but in only 15 per cent. of the samples of effluent from Filter No. 8A collected during 1908 and in only 5 per cent. of the samples during 1909.

Average Chemical Analyses.

Effluent of Filter No. 8A.

[Parts per 100,000.]

Year.	Quantity Applied. Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as— Nitrates.	Nitrogen as— Nitrites.	Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
1908, . .	2,672,200	54	0.0	.25	.0019	.0082	.44	.025	.0002	.37	46.6	1.0
1909, . .	2,944,000	55	0.0	.26	.0035	.0108	.46	.022	.0002	.45	27.5	1.1
Effluent of Filter No. 343.												
1908, . .	4,891,900	63	0.0	.27	.0032	.0096	.46	.026	.0006	.39	51.1	1.3
1909, . .	4,866,300	54	0.0	.27	.0056	.0105	.46	.026	.0004	.47	23.0	1.2

Average Bacterial Analyses.

Effluent of Filter No. 8A.

Year.	Bacteria per Cubic Centimeter. 20° C.	Bacteria per Cubic Centimeter. 40° C. Total.	Bacteria per Cubic Centimeter. 40° C. Red.	Per Cent. of Bacteria Removed. 20° C.	Per Cent. of Bacteria Removed. 40° C. Total.	Per Cent. of Bacteria Removed. 40° C. Red.	Per Cent. of Samples containing B. Coli. 1 c. c.
1908, ...	90	5	1	99.0	95.6	97.8	15.0
1909, ...	48	6	2	99.1	94.8	96.7	5.0
Effluent of Filter No. 343.							
1908,[1]	236	8	2	95.9	94.5	97.7	24.8
1909, ...	85	9	3	98.4	92.2	95.0	24.2

[1] Omitting first month of operation.

Studies of the Relative Efficiency of Slow Sand Filters operated at Different Rates.

Filters Nos. 220, 244, 281 and 330.

On Feb. 24, 1908, new sand was added to Filters Nos. 220, 244 and 281 and sand was removed from the surface of Filter No. 330 in such amounts that all the filters contained approximately 40 inches in depth of sand of an effective size between 0.20 and 0.24 millimeter. During the remainder of 1908 and throughout 1909, Filter No. 330 was operated at a rate of 5,000,000 gallons, Filter No. 281 at a rate of 7,500,000 gal-

lons, Filter No. 220 at a rate of 10,000,000 gallons and Filter No. 244 at a rate of 20,000,000 gallons, the surfaces of all being washed when necessary to relieve clogging in order that the depth of sand might remain the same. The surface of Filter No. 330 was thus washed thirty-four times; that of Filter No. 281, ninety-four times; that of Filter No. 220, ninety-six times, and that of Filter No. 244, one hundred and thirty times during the twenty-one months they were operated in this manner. In addition to washing it was necessary to scrape Filter No. 330 twice; Filter No. 281 twice; Filter No. 220 ten times, and Filter No. 244 thirteen times during the same period. The average volume of water filtered between washings was about 83,000,000 gallons per acre for Filter No. 330; about 41,000,000 gallons per acre for Filter No. 281; about 56,000,000 gallons per acre for Filter No. 220, and about 72,000,000 gallons per acre for Filter No. 244. A comparison of these quantities with the rates at which the filters were operated would not be a fair one, as the term of service and previous history of the filters was not the same and the sand in some of the filters contained a greater amount of organic matter than was the case with others. The fact that Filters Nos. 220 and 244, which were operated at rates of 10,000,000 and 20,000,000 gallons per acre daily, respectively, were *scraped* more frequently than the other two filters, would also influence the quantity of water filtered between surface washings. Comparing the purification results of these four filters, it will be noted that chemically the effluent from Filter No. 330, operated at a rate of 5,000,000 gallons per acre daily, was slightly better than those from the other three filters, operated at higher rates, but that there was not much difference between the effluents of Filters Nos. 281, 220 and 244. The only regular difference to be observed is seen in the amount of albuminoid ammonia, which increased with the rate of operation. Bacterially, none of the effluents were entirely satisfactory. The results of the bacterial analyses show no apparent relation between the rate of filtration and the quality of the effluent, except that the effluent from the filter operated at a 20,000,000-gallon rate was the poorest. The effluent from the filter operated at a 7,500,-000-gallon rate was slightly better bacterially than that from the filter operated at a 10,000,000-gallon rate, but the effluent from the filter operated at a 5,000,000-gallon rate was not so good as those from filters operated at the 7,500,000 and 10,000,000 gallon rates. It is not possible at this time to explain these discrepancies further than to state that these filters were operated at rates much higher than have been found practicable in filtering a water as highly polluted as that from the Merrimack River.

The average analyses of the effluents from these filters during both years are shown in the following tables: —

Average Chemical Analyses.

Effluent of Filter No. 330.

[Parts per 100,000.]

Year.	Quantity Applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as—		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.	Age of Filter.[1]
			Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.				
1908	4,911,000	62	0.0	.26	.0024	.0081	.46	.026	.0002	.37	50.6	1.1	6 months.
1909	4,929,000	56	0.0	.27	.0025	.0111	.46	.029	.0003	.47	32.6	1.0	

Effluent of Filter No. 281.

1908	6,740,000	60	0.0	.26	.0034	.0095	.45	.022	.0004	.40	37.5	1.1	2 years, 1 month.
1909	7,041,300	53	0.0	.29	.0068	.0119	.45	.024	.0002	.48	34.3	1.1	

Effluent of Filter No. 220.

1908	8,546,000	60	0.0	.28	.0046	.0098	.45	.020	.0005	.40	41.0	1.0	4 years, 5 months.
1909	7,804,000	55	0.0	.29	.0061	.0121	.45	.023	.0001	.48	34.8	1.1	

Effluent of Filter No. 244.

1908	17,695,000	61	0.0	.27	.0036	.0103	.44	.023	.0004	.38	45.7	1.1	3 years, 10 months.
1909	16,184,000	53	0.0	.29	.0056	.0126	.46	.027	.0005	.49	43.3	1.1	

[1] Jan. 1, 1908.

Average Bacterial Analyses.

Effluent of Filter No. 330.

Year.	Quantity Applied. — Gallons per Acre Daily.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.	Age of Filter.[1]
		20° C.	40° C.		20° C.	40° C.			
			Total.	Red.		Total.	Red.	1 c. c.	
1908	4,911,000	275	11	3	97.2	89.6	94.5	28.0	6 months.
1909	4,929,000	250	10	4	95.4	91.3	93.3	26.1	

Effluent of Filter No. 281.

1908	6,740,000	96	7	2	98.2	93.4	96.5	28.1	2 years, 1 month.
1909	7,041,300	105	11	3	98.1	90.4	95.0	25.5	

[1] Jan. 1, 1908.

Average Bacterial Analyses — Concluded.

Effluent of Filter No. 220.

Year.	Quantity Applied. — Gallons per Acre Daily.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.	Age of Filter.[1]
		20° C.	40° C.		20° C.	40° C.		1 c. c.	
			Total.	Red.		Total.	Red.		
1908	8,546,000	192	11	4	96.5	89.0	93.1	34.9	4 years, 5 months.
1909	7,804,000	110	9	3	98.0	92.2	95.0	24.6	

Effluent of Filter No. 244.

1908	17,695,000	510	15	5	91.1	86.3	91.1	45.8	3 years, 10 months.
1909	16,184,000	280	15	7	94.8	87.0	88.4	37.7	

[1] Jan. 1, 1908.

Filtration of Water less polluted than that of the Merrimack River Water.

Filter No. 340, 1/20000 of an acre in area, constructed of 48 inches in depth of sand of an effective size of 0.23 millimeter, was started Feb. 27, 1908, to study the purification of water less polluted than that of the Merrimack River. This filter was operated with a mixture of canal water and city water, at a rate of 2,500,000 gallons per acre daily, until it had become matured. From June 1, 1908, until Nov. 30, 1908, its rate was 5,000,000 gallons per acre daily. The surface of this filter was scraped three times during the nine months it was operated, the average volume filtered between scrapings being over 330,000,000 gallons per acre. The average chemical and bacterial analyses of the applied water and effluent from this filter are shown in the following tables: —

Average Chemical Analyses.

Applied Water for Filter No. 340.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance.		Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.			
–	68	0.3	.36	.0091	.0144	.52	.024	.0003	.41	59.8	1.5

Effluent of Filter No. 340.

5,331,000	68	0.0	.25	.0026	.0075	.53	.032	.0001	.33	38.0	1.5

Average Bacterial Analyses.

Applied Water for Filter No. 340.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
3,000	48	28	-	-	-	71.2
Effluent of Filter No. 340.						
150	4	1	95.0	91.7	96.4	16.8

Double Filtration.

Three systems of double filters were operated during 1908 and one system during 1909. The primary filters in two of these systems were operated at high rates and the secondary filters at much lower rates, while in the third system the primary filter was operated at a lower rate than the secondary filter. During 1909 the effluent from primary Filter No. 331 was treated with a disinfectant before being applied to secondary Filter No. 286, and a discussion as to the comparative efficiency of this system during the two years will be found on page 326.

Filters Nos. 220 and 244.

Filter No. 220, $\frac{1}{5000}$ of an acre in area, containing 30 inches in depth of sand of an effective size of 0.20 millimeter, and first put into operation in July, 1903, was operated during the first three months of 1908 with canal water at a rate of 10,000,000 gallons per acre daily. The effluent from this filter was refiltered through Filter No. 244 at a rate of 20,000,000 gallons per acre daily. Filter No. 244 $\frac{1}{20000}$ of an acre in area, and constructed of about 36 inches in depth of sand of an effective size of 0.24 millimeter, was first put into operation in February, 1904. Filter No. 220 was scraped five times and Filter No. 244 was scraped once during the three months they were operated together. Considering the two filters as a system the net rate was about 6,600,000 gallons. After Feb. 24, 1908, these filters were used in experiments as to the relative efficiency of filters operated at different rates.

Filters Nos. 280 and 281.

These two filters were first put into operation in November, 1905. Filter No. 280, $\frac{1}{20000}$ of an acre in area, contained about 6 inches in depth of sand of an effective size of 0.30 millimeter, and was operated throughout 1908 as a pre-filter at a rate of 25,000,000 gallons per acre daily. Filter No. 281, $\frac{1}{10000}$ of an acre in area, contained 39 inches in depth of sand of an effective size of 0.23 millimeter, and was operated as a secondary filter during the first three months of 1908, with the effluent from Filter No. 280, at a rate of 7,500,000 gallons per acre daily. After Feb. 24, 1908, this filter was operated with canal water, as described on page 309. The surface of Filter No. 280 was washed seventy-two times during the year, the average volume of water filtered between washings being about 106,000,000 gallons per acre. The surface of Filter No. 281 was scraped four times during the period it was operated as a secondary filter, the average volume of water filtered between scrapings being about 82,000,000 gallons per acre. Considering these two filters as a system, the average net rate was about 5,800,000 gallons per acre.

In addition to the above filters, a mechanical filter, operated in one of the mills with settled canal water without the use of coagulants, was studied during the six months from Nov. 1, 1907, to April 30, 1908, inclusive. This filter, with a capacity of about 2,000,000 gallons daily, contained about 24 inches in depth of sand of an average effective size of about 0.45 millimeter, and was operated at a rate of 100,000,000 gallons per acre daily. The canal water received about four hours' storage in a settling tank before being applied to the filter. This filter in depth and size of material and in rate and method of operation was practically a duplicate of Filter No. 331, and the studies have afforded excellent chance to compare the efficiency of an experimental filter operated under careful supervision with that of a similar filter built on a large scale and operated with only the supervision necessary to obtain the requisite volume of water.

The average analyses of these primary and secondary filters are shown in the following tables: —

Average Chemical Analyses of Effluents from Double Filters.

Primary Filter No. 220.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen Consumed.	Hardness.	Dissolved Oxygen (Per Cent. of Saturation).	Age of Filter.[1]
8,651,000	38	0.0	.33	.0016	.0090	.29	.020	.0001	.40	0.6	55.5	3 months.
Secondary Filter No. 244.												
19,741,000	38	0.0	.32	.0014	.0082	.30	.021	.0000	.37	0.6	80.8	3 months.
Pre-filter No. 280.												
23,332,900	55	0.1	.34	.0050	.0121	.41	.024	.0003	.43	0.9	56.8	1 year.
Secondary Filter No. 281.												
5,458,000	38	0.0	.33	.0017	.0078	.29	.021	.0000	.39	0.6	69.6	3 months.
Mill Filter.												
–	37	0.1	.38	.0058	.0130	.29	.014	.0001	.47	0.6	–	–

[1] Jan. 1, 1908.

Average Bacterial Analyses. Double Filtration Systems.

Effluent from Primary Filter No. 220.

Quantity Applied. — Gallons per Acre Daily.	Bacteria per Cubic Centimeter. 20° C.	Bacteria per Cubic Centimeter. 40° C. Total.	Bacteria per Cubic Centimeter. 40° C. Red.	Per Cent. of Bacteria Removed. 20° C.	Per Cent. of Bacteria Removed. 40° C. Total.	Per Cent. of Bacteria Removed. 40° C. Red.	Per Cent. of Samples containing B. Coli. 1 c. c.	Age of Filter.[1]
8,651,000	160	16	10	93.8	89.0	89.5	46.1	3 months.
Effluent from Secondary Filter No. 244.								
19,741,000	80	11	6	58.0	54.2	40.0	28.9	3 months.

[1] Jan. 1, 1908.

Average Bacterial Analyses. Double Filtration Systems — Concluded.

Effluent from Pre-filter No. 280.

Quantity Applied. — Gallons per Acre Daily.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.	Age of Filter.[1]
	20° C.	40° C.		20° C.	40° C.			
		Total.	Red.		Total.	Red.	1 c. c.	
23,332,900	1,500	37	20	80.8	71.6	77.8	64.7	1 year.
Effluent from Secondary Filter No. 281.								
5,458,000	43	7	3	91.9	84.8	90.3	37.1	3 months.
Settled Canal Water applied to Mill Filter.								
–	4,500	130	85	–	0.0	10.5	100.0	–
Effluent from Mill Filter.								
–	1,900	85	55	57.7	34.7	35.3	100.0	–

[1] Jan. 1, 1908.

Slow Sand Filtration with the Aid of Coagulants.

Filter No. 330, $\frac{1}{20000}$ of an acre in area, and containing about 43 inches in depth of sand of an effective size of 0.21 millimeter, was started July 7, 1907. During the first three months of 1908 it was operated at a rate of 5,000,000 gallons per acre daily with canal water which had been treated with sulphate of alumina in amounts varying from one-half to one grain per gallon, and allowed to settle about nine and one-half hours. The amount of color removed by this process was not materially greater than that by other slow sand filters operating without coagulant, except in the later experiments, in which the amount of sulphate of alumina was increased to about that required in the operation of mechanical filters. The surface of the filter was washed twenty-three times during this period, the average quantity of water filtered between washings being about 32,300,000 gallons per acre. After February 24 the application of coagulants was stopped, and the filter was then used in studies of different rates, as described elsewhere.

The results of the operation of this filter during the period when coagulants were used are shown in the following tables: —

Average Chemical Analyses.

Water applied to Filter No. 330.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen Consumed.	Hardness.	Dissolved Oxygen (Per Cent. of Saturation).
–	36	0.0	.37	.0064	.0135	.0120	.30	.019	.0003	.48	0.6	86.8
Effluent from Filter No. 330.												
4,558,000	44	0.0	.29	.0014	.0075	–	.29	.021	.0001	.34	0.4	80.5

Average Bacterial Analyses.

Canal Water (Merrimack River Water).

Bacteria per Cubic Centimeter. 20° C.	Bacteria per Cubic Centimeter. 40° C. Total.	Bacteria per Cubic Centimeter. 40° C. Red.	Per Cent. of Bacteria removed. 20° C.	Per Cent. of Bacteria removed. 40° C. Total.	Per Cent. of Bacteria removed. 40° C. Red.	Per Cent. of Samples containing B. Coli. 1 c. c.
2,600	95	65	–	–	–	100.0
Effluent from Coagulation Basin applied to Filter No. 330.						
1,800	44	25	–	–	–	100.0
Effluent from Filter No. 330.						
110	12	5	93.9	72.8	80.0	22.5

Studies of Disinfection as an Adjunct to Water Purification.

Studies concerning the use of disinfectants in connection with water and sewage purification have been in progress at Lawrence for a number of years. The results of experiments with copper treatment have been fully discussed already on pages 289 to 338 of the report for 1905. During the past two years special studies have been made concerning the use of hypochlorite of lime and permanganate of potash in water purification, to determine what amounts of these substances are required to produce complete sterilization of waters polluted in varying degrees, and what

amounts are necessary in filtration at high rates in order to secure an effluent of the same *bacterial* quality as those from the best slow sand filters. The actions of hypochlorites and permanganates in water are quite similar; both are oxidizing agents, and it is to oxidation that their disinfecting action is due. Unlike copper salts, neither of them retains its identity for any length of time in water, and it does not seem probable that the slight increase in the permanent hardness caused by the use of hypochlorite of lime, or the small traces of manganese which may remain in solution after permanganate treatment, can have any physiological action upon the consumer.

The fact that the numbers of bacteria in water are considerably reduced by the use of permanganates has been known for many years, and the permanganates of potash, of soda and of lime have been employed to a limited extent in a number of places. During the Boer war, potassium permanganate was used to disinfect drinking water for the British troops in the field. At Bloemfontein, South Africa, for some years permanganates have been added to the water as it enters the storage reservoir. The details of the treatment are not available, but the results are stated to be fairly satisfactory. The use of permanganates for the removal of color and iron was investigated at the experiment station in 1900, and, as stated on page 462 of the report for that year, the results of the process were not particularly satisfactory with the water studied.

During the past two years a large number of laboratory experiments have been made to determine the disinfecting power of potassium permanganate when added to water in various proportions, and allowed to stand for periods varying from a few minutes to a number of weeks. A complete sterilization of the water was not effected in any of these experiments, even when the action was continued for many days. Over 98 per cent. of the bacteria were eliminated by treatment for four to six hours with 0.5 part per 100,000, but larger amounts of permanganate, or a continuation of the action for more than six hours, did not result in any further appreciable decrease in the numbers of bacteria. The reduction in numbers of bacteria growing at body temperature was much less than that of the common water bacteria, varying from 50 to 75 per cent., and considerable numbers of these types of bacteria, including many B. coli, were found in a majority of the samples after treatment. In fact, the numbers of bacteria determined at body temperature were frequently much higher than the numbers determined at room temperature.

The cost of treatment with 0.5 part $KMNO_4$ per 100,000 is from $3 to $4 per million gallons.

During the past few years various forms of chlorine have been brought

forward for disinfection of water and sewage on account of their cheapness and efficiency, and the hypochlorites of lime and of sodium have been used in a number of cases in this country and abroad for treating public water supplies.

A large number of experiments have been made at the experiment station to determine the effect of various amounts of calcium hypochlorite, and the effect of varying lengths of storage after treatment, upon the bacteriological content of Merrimack River water, of sewage and of the effluents from many different types of water and sewage filters. These experiments show that the disinfecting power of the hypochlorite is exhausted in one to two hours if small amounts are used, but that, if large amounts are required, four to six hours or even longer storage is necessary before the action is complete. In general, the treatment of Merrimack River water with hypochlorite of lime equivalent to 0.1 part per 100,000 available chlorine caused a bacterial reduction of over 99 per cent., and resulted in an effluent corresponding in bacterial quality with the effluents from the best slow sand filters. Much larger amounts were required, however, to produce complete sterilization. In many of the experiments hypochlorite equivalent to nearly 4.0 parts available chlorine per 100,000 was insufficient to produce complete sterilization. The removal of the types of bacteria growing at body temperature, in which class would be found disease-producing bacteria, was in nearly every case less than the reduction in total bacterial content, and very much larger amounts of disinfectant were required to produce an effluent corresponding in this respect to good slow sand filter effluents than was the case when the total bacterial count was used as a basis for comparison. Furthermore, it has been frequently observed that the numbers of bacteria determined at body temperature in the disinfected samples were much higher than the numbers determined by the usual room temperature count.

This phenomenon of reversed ratios between counts at the two temperatures has been observed occasionally with natural waters, but a study of the records of many thousand samples shows that the percentage of such samples is very small, not over 3 to 5 per cent. On the other hand 20 to 25 per cent. of samples treated with calcium hypochlorite show higher counts at body temperature than at room temperature. Similar counts have been noted elsewhere, where waters are being treated with hypochlorites, but in many cases such results have been considered abnormal and have been omitted from the records. A phenomenon which has a frequency of 25 per cent., however, cannot under any circumstances be considered abnormal, and the omission of such counts from the records is entirely unjustifiable. A careful study has been made of the conditions

under which such reversed counts occur, and it appears that these counts are found in a considerable percentage of samples of water, sewage, etc., in which the room temperature counts have been reduced to less than 100 to 200 per cubic centimeter by the use of hypochlorites, permanganates or other oxidizing disinfectants. They are not commonly observed in samples containing large numbers of bacteria nor in samples in which the numbers have been reduced by the action of copper sulphate or other non-oxidizing disinfectants. A study of the types of bacteria remaining after disinfection with hypochlorites shows that the proportion of spore-forming bacteria is practically the same after disinfection as it was in the untreated water, and the appearance of the reversed ratios apparently cannot be attributed entirely to the non-destruction of spores. The true significance of this phenomenon cannot be stated at this time. It is evident, however, that if the body temperature counts are omitted and reliance placed entirely upon those at room temperature, a wrong and possibly dangerous interpretation may be made as to the quality of a water which has been purified by treatment with hypochlorites.

Mechanical Filtration with and without the use of a Disinfectant.

Filter No. 336, $\frac{1}{40000}$ of an acre in area, and containing 24 inches in depth of sand of an effective size of 0.35 millimeter, was first put into operation Dec. 11, 1907. This filter has been operated as a mechanical filter at a rate of 100,000,000 gallons per acre daily throughout 1908 and 1909, filtering canal water which has been treated first with sulphate of alumina and soda ash, and then passed through a settling tank with a storage capacity of three and one-fourth hours. During the first four months of operation the coagulants were varied considerably in amount, and it was found that while a fairly satisfactory effluent from a chemical and physical viewpoint could be obtained by the use of about 1 grain sulphate of alumina and 0.75 grain per gallon of soda ash, an effluent containing low numbers of bacteria could only be obtained by the use of about 2 grains sulphate of alumina and 1.5 grains soda ash per gallon. During the remainder of the year coagulants in about these proportions were added, and a fairly satisfactory effluent was obtained. This effluent, however, was not at all times of good quality bacterially, as compared with the effluents from sand filters operated at low rates without coagulants. On Dec. 1, 1908, application of calcium hypochlorite to the raw water before it entered the settling tank was begun, the aim being to add coagulants in such amounts only as were necessary to produce a water of satisfactory appearance, and to control the bacterial quality of the filter effluent by the use of the disinfectant. From December 1 to March 15, the use of soda was omitted, and only so much sulphate of alumina

was used as would be decomposed by the natural alkalinity of the water. The results of operation without the addition of alkali were not satisfactory. While the natural alkalinity of the water was theoretically sufficient to decompose much more than the required amount of sulphate of alumina, in practice it was found that undecomposed alum appeared in the effluent at times unless the alkalinity of the filtered water was kept above 0.7 part per 100,000. As a proper clarification of the water by a smaller amount of coagulant could not be accomplished, the use of soda was again begun, the soda ash and the hypochlorite of lime in the proper proportions being dissolved in the same chemical tank and added to the water as a single solution. The results of the operation of this filter with simple coagulation during 1908 and with combined coagulation and disinfection during 1909 are shown in the accompanying tables, but for purposes of comparison only the periods from April to November in each year, when the filter was in normal operation, will be considered.

During this period in 1908 the chemicals used averaged 1.86 grains per gallon sulphate of alumina and 1.55 grains per gallon soda ash. During the same period in 1909 the sulphate of alumina averaged 0.91 grain per gallon, the soda ash 0.71 grain per gallon and bleach equivalent to 0.11 part per 100,000 available chlorine was added. The use of smaller amounts of coagulant during the period of combined disinfection and coagulation resulted in an increase of nearly 25 per cent. in the quantity of water passed through the filter between washings, and also in a material reduction in the cost of chemicals. With sulphate of alumina and soda at 1 cent per pound, and bleaching powder averaging 37 per cent. available chlorine at 1¼ cents per pound, the cost for chemicals averaged about $4.86 per million gallons for coagulation alone, and about $2.62 per million gallons for combined disinfection and coagulation.

From a physical and chemical viewpoint the effluent from the filter was more satisfactory during the first period than during the second period, when the amounts of coagulants were much less. When coagulation alone was used the average removal of color was about 75 per cent. and the removal of almubinoid ammonia was 62 per cent. During the period of combined coagulation and disinfection the color removal averaged about 57 per cent. and the removal of albuminoid ammonia averaged 42 per cent. During both periods the filtered water was free from turbidity and sediment. While the amount of organic matter in the effluent was higher during the latter period, when sulphate of alumina was being used in combination with bleach, than during the earlier period, when larger amounts of coagulant were being used alone, the values stated are no higher than those found in many municipal water supplies considered to be of good quality. The amount of color in the filtered water during the latter period of operation averaged 0.15, and was probably as high

as could be allowed in practice without becoming noticeable. Better removal of color and organic matter could have been obtained during the latter period by increasing the coagulant, but this would have increased the cost and have defeated the object of the experiment. During neither period was any trace of sulphate of alumina detected in the filtered water, and during the period when bleach was added to the raw water, hypochlorites were never found in the effluent from the filter. No taste or odor was noticed in any of the samples when they were examined in their natural state, but when heated a very faint odor of bleaching powder could be detected occasionally. This odor was so slight that it would hardly have been noticed unless it had been carefully sought.

From a bacteriological viewpoint the results of combined coagulation and disinfection were far better than those obtained by coagulation alone, the average removal of bacteria by the combined process being 99.8 per cent., as compared with a removal of 98.0 per cent. during the corresponding period when no disinfectant was used. The effect of disinfection was most noticeable in the character of the water as it flowed to the filter from the coagulation and sedimentation basin. Here a removal of 99.7 per cent. of the bacteria was effected during the disinfection period, as compared with a removal of 75.7 per cent. during the period when coagulants alone were used. During the period of simple coagulation the average number of bacteria in the water applied to the filter after treatment was 2,500 per cubic centimeter, and in the filter effluent was 204 per cubic centimeter, while during the period when bleach was used the numbers of bacteria averaged 15 per cubic centimeter in the basin effluent and 8 per cubic centimeter in the filtered water. Not only was the combined coagulation and disinfection more satisfactory as judged by the removal of bacteria, but it was eminently more satisfactory as judged by the consistently low numbers of bacteria both in the effluent from the coagulation and sedimentation basin and in the effluent from the filter. To state the bacterial results differently, about 30 per cent. of the samples of filter effluent contained more than 100 bacteria per cubic centimeter, and B. coli were present in 1 cubic centimeter in 12 per cent. of the samples when coagulation alone was used, while only about 1 per cent. of the filtered water samples contained more than 100 bacteria per cubic centimeter, and B. coli were not found in 1 cubic centimeter of the effluent when the disinfectant was employed. Furthermore, during the disinfection period none of the samples of the settling basin effluent contained more than 1,000 bacteria per cubic centimeter, and only about 2 per cent. contained more than 100 bacteria per cubic centimeter. Filtration in this case acted merely as a factor of safety so far as bacterial quality was concerned, the elimination of bacteria being effected practically in the coagulation and sedimentation basin. On the other hand,

when coagulation alone was practiced, over 54 per cent. of the samples of the basin effluent contained 1,000 or more bacteria per cubic centimeter, and the burden of producing a bacterially safe water fell upon the filtering medium.

The peculiar action of hypochlorite treatment upon the types of bacteria determined at body temperature, which has been noted previously, has been particularly noticeable in the daily results of the continuous disinfection experiments. With the comparatively small amounts of disinfectant used, a practically complete sterilization would be obtained frequently, judging from the room temperature counts, whereas the body temperature counts would show only a very slight reduction. As the operation of the filter was continued, the amounts of disinfectant which were non-effective in reducing satisfactorily the body temperature counts were also shown to be ineffective occasionally in reducing the room temperature counts, and samples giving high room temperature counts were obtained at times under such conditions. In the later experiments, when the amount of disinfectant had been increased somewhat, consistently low numbers of bacteria as determined at room temperature were obtained, accompanied by satisfactory body temperature counts.

The average results of operation during the two periods are shown in the following tables: —

Average Chemical Analyses.

Canal Water (Merrimack River Water).

[Parts per 100,000.]

YEAR.	Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS —		Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
		Turbidity.	Color.	Free.	ALBUMINOID.			Nitrates.	Nitrites.			
					Total.	In Solution.						
1908, . . .	54	0.4	.41	.0127	.0192	.0144	.40	.014	.0005	.50	75.9	1.0
1909, . . .	54	0.5	.35	.0182	.0228	.0182	.47	.015	.0009	.63	60.7	1.1
Effluent from Coagulation Basin.												
1908, . . .	57	0.6	.27	.0161	.0189	.0146	.48	.016	.0005	.40	64.7	1.4
1909, . . .	57	0.7	.27	.0203	.0208	–	.72	.016	.0001	.54	57.2	0.9
Effluent from Filter No. 336.												
1908, . . .	57	0.0	.15	.0142	.0084	–	.46	.016	.0004	.28	76.3	1.2
1909, . . .	56	0.0	.15	.0179	.0128	–	.69	.015	.0002	.40	64.9	1.0

Relative Cost of Chemicals for Mechanical Filtration with and without Disinfection.

Date.	Chemicals used (Grains per Gallon). 1907-08. Sulphate Alumina.	Chemicals used 1907-08. Soda Ash.	Chemicals used 1908-09. Sulphate Alumina.	Chemicals used 1908-09. Soda Ash.	Chemicals used 1908-09. Bleach.	Chemicals used 1908-09. Chlorine.[1]	Cost per Million Gallons filtered. 1907-08. Sulphate Alumina.	Cost 1907-08. Soda Ash.	Cost 1907-08. Total.	Cost 1908-09. Sulphate Alumina.	Cost 1908-09. Soda Ash.	Cost 1908-09. Bleach.	Cost 1908-09. Total.
December,	0.85	0.38	0.91	–	.102	.07	$1 22	$0 54	$1 76	$1 30	–	$0 18	$1 48
January,	1.06	0.57	0.92	–	.102	.07	1 52	82	2 34	1 32	–	18	1 50
February,	1.37	0.91	0.89	–	.111	.07	1 96	1 30	3 26	1 27	–	20	1 47
March,	1.63	0.95	0.85	0.24[2]	.221	.14	2 33	1 36	3 69	1 22	$0 34[2]	40	1 96
April,	1.92	1.39	0.83	0.64	.183	.12	2 75	1 99	4 74	1 19	93	33	2 45
May,	1.86	1.52	0.91	0.70	.144	.09	2 66	2 17	4 83	1 30	1 00	26	2 56
June,	1.84	1.55	0.88	0.68	.175	.11	2 63	2 22	4 85	1 26	97	31	2 54
July,	1.77	1.51	0.85	0.66	.180	.12	2 53	2 16	4 69	1 22	95	32	2 49
August,	1.88	1.60	0.93	0.69	.180	.12	2 59	2 29	4 88	1 33	99	32	2 64
September,	1.81	1.58	0.96	0.75	.167	.11	2 59	2 26	4 85	1 37	1 07	30	2 74
October,	1.79	1.61	1.04	0.83	.184	.12	2 56	2 30	4 86	1 49	1 19	33	3 01
November,	1.97	1.67	0.89	0.70	.164	.11	2 82	2 39	5 21	1 27	1 00	30	2 57
Average,[3]	1.65	1.27	0.91	0.65	.160	.10	$2 35	$1 82	$4 17	$1 30	$0 94	$0 29	$2 53
Average,[4]	1.86	1.55	0.91	0.71	.172	.11	$2 64	$2 22	$4 86	$1 30	$1 01	$0 31	$2 62

[1] Available chlorine, parts per 100,000.
[2] No soda used until March 15.
[3] Average, December to November, inclusive.
[4] Average, April to November, inclusive.

Relative Removal of Bacteria, Color and Organic Matter by Mechanical Filtration with and without Disinfection.

1907-08. — Period of Coagulation Alone.

Date.	Per Cent. of Bacteria removed. In coagulation basin. 20° C.	In coagulation basin. 40° C. Total.	In coagulation basin. 40° C. Red.	By entire system. 20° C.	By entire system. 40° C. Total.	By entire system. 40° C. Red.	Per Cent. Reduction of Color.	Per Cent. Reduction of Albuminoid Ammonia.	Per Cent. Reduction of Oxygen Consumed.
December,	52.2	40.0	51.7	94.1	80.0	76.7	47.5	40.0	47.0
January,	31.8	46.2	50.9	93.2	91.2	89.1	62.2	19.9	6.5
February,	53.0	66.7	80.0	92.7	97.5	98.7	82.4	57.9	54.2
March,	0.0	29.4	48.3	70.2	77.6	75.0	62.8	28.5	0.0
April,	35.0	27.2	67.8	95.5	87.3	93.5	80.0	52.5	49.0
May,	82.3	77.3	86.0	99.3	98.7	100.0	89.7	69.1	67.9
June,	85.0	75.8	80.0	98.8	97.6	97.6	79.2	54.4	60.4
July,	61.5	61.2	70.0	98.0	95.0	96.9	73.9	45.7	21.4
August,	56.7	64.6	71.7	97.7	94.2	96.7	70.8	60.3	60.0
September,	76.4	79.1	90.0	99.6	99.0	100.0	80.5	74.8	64.4
October,	86.9	81.0	88.9	98.7	98.5	99.3	75.6	65.8	49.1
November,	67.6	49.4	85.3	94.1	97.6	97.1	56.3	69.9	51.6
Average,[1]	70.6	63.9	76.6	96.7	94.6	95.6	72.5	56.3	44.0
Average,[2]	75.7	68.7	79.0	98.0	96.7	98.0	75.6	62.4	53.0

[1] Average, December to November, inclusive.
[2] Average, April to November, inclusive.

Relative Removal of Bacteria, Color and Organic Matter, etc. — Concluded.

1908–09. — Period of Combined Coagulation and Disinfection.

Date.	Per Cent. of Bacteria removed. In coagulation basin. 20° C.	In coagulation basin. 40° C. Total.	In coagulation basin. 40° C. Red.	By entire system. 20° C.	By entire system. 40° C. Total.	By entire system. 40° C. Red.	Per Cent. Reduction of Color.	Albuminoid Ammonia.	Oxygen Consumed.
December,	90.6	50.0	80.0	98.9	88.6	94.3	45.5	20.7	5.3
January,	72.2	29.4	85.0	99.0	88.2	95.0	41.7	32.7	10.0
February,	98.9	70.0	88.3	99.5	95.6	100.0	68.8	61.8	64.3
March,	94.5	80.0	91.4	99.6	98.6	100.0	81.6	74.0	71.7
April,	98.3	86.7	93.7	98.6	98.3	100.0	56.7	24.7	18.3
May,	99.4	92.3	96.8	99.6	98.5	100.0	54.1	62.4	64.0
June,	99.2	98.5	100.0	99.9	99.5	100.0	76.2	36.4	45.3
July,	99.7	97.7	99.0	99.9	99.5	100.0	51.3	21.5	21.7
August,	99.7	94.4	96.4	99.9	98.9	100.0	73.6	62.6	53.8
September,	99.9	98.3	100.0	99.9	99.4	100.0	50.0	23.7	25.7
October,	99.8	95.7	98.0	99.9	99.9	100.0	22.0	37.5	29.3
November,	99.9	85.7	92.6	99.9	97.6	100.0	63.0	57.0	62.3
Average,[1]	95.1	87.0	95.0	99.6	97.2	100.0	57.2	43.9	36.5
Average,[2]	99.7	96.2	98.6	99.8	99.2	100.0	57.2	42.0	39.6

[1] Average, December to November, inclusive.
[2] Average, April to November, inclusive.

Relative Numbers of Bacteria during Mechanical Filtration with and without Disinfection.

1907–08. — Period of Coagulation Alone.

Date.	Merrimack River Water. Bacteria per cubic centimeter. 20° C.	40° C. Total.	40° C. Red.	Effluent from Coagulation Basin. Bacteria per cubic centimeter. 20° C.	40° C. Total.	40° C. Red.	Per Cent. of 1 Cubic Centimeter Samples containing B. Coli.	Effluent from Filter. Bacteria per cubic centimeter. 20° C.	40° C. Total.	40° C. Red.	Per Cent. of 1 Cubic Centimeter Samples containing B. Coli.
December,	2,300	80	60	1,100	48	29	93.0	135	16	14	35.7
January,	2,200	80	55	1,500	43	27	89.0	150	7	6	7.4
February,	3,300	120	80	1,550	40	16	85.8	240	3	1	4.8
March,	3,100	85	48	3,400	60	20	77.8	925	19	12	27.8
April,	2,000	55	31	1,300	40	10	80.0	90	7	2	8.0
May,	3,500	75	50	620	17	7	6.3	24	1	0	0.0
June,	8,000	165	125	1,200	40	25	71.0	100	4	3	20.8
July,	3,900	180	130	1,500	70	39	73.1	80	9	4	11.5
August,	11,300	240	180	4,900	85	51	100.0	260	14	6	29.2
September,	14,000	210	130	3,300	44	13	90.0	60	2	0	15.0
October,	28,900	200	135	3,800	38	15	100.0	380	3	1	14.3
November,	10,800	85	34	3,500	43	5	50.0	640	2	1	0.0
Average,[1]	7,800	130	90	2,300	47	21	76.3	260	7	4	14.5
Average,[2]	10,300	150	100	2,500	47	21	71.3	204	5	2	12.3

[1] Average, December to November, inclusive.
[2] Average, April to November, inclusive.

Relative Numbers of Bacteria during Mechanical Filtration, etc. — Concluded.

1908–09. — Period of Combined Coagulation and Disinfection.

Date.	Merrimack River Water. Bacteria per Cubic Centimeter. 20° C.	40° C. Total.	40° C. Red.	Effluent from Coagulation Basin. Bacteria per Cubic Centimeter. 20° C.	40° C. Total.	40° C. Red.	Per Cent. of 1 Cubic Centimeter Samples containing B. Coli.	Effluent from Filter. Bacteria per Cubic Centimeter. 20° C.	40° C. Total.	40° C. Red.	Per Cent. of 1 Cubic Centimeter Samples containing B. Coli.
December, .	8,100	70	35	760	35	7	0.0	90	8	2	0.0
January, .	7,200	85	40	2,000	60	6	0.0	70	10	2	4.3
February, .	3,700	90	34	41	27	4	0.0	17	4	0	0.0
March, .	4,700	70	35	260	14	3	7.2	2	1	0	0.0
April, . .	3,000	60	32	52	8	2	0.0	41	1	0	0.0
May, . .	1,600	65	31	10	5	1	0.0	7	1	0	0.0
June, . .	7,200	200	60	6	3	0	4.5	2	1	0	0.0
July, . .	4,800	220	100	12	5	1	0.0	3	1	0	0.0
August, .	2,000	90	55	6	5	2	0.0	2	1	0	0.0
September, .	6,200	175	130	4	3	0	4.2	3	1	0	0.0
October, .	11,800	210	150	22	9	3	0.0	6	2	0	0.0
November, .	4,300	42	27	6	6	2	0.0	2	1	0	0.0
Average,[1] .	5,400	115	60	265	15	3	1.3	20	3	0	0.0
Average,[2] .	5,100	133	73	15	5	1	1.1	8	1	0	0.0

[1] Average, December to November, inclusive.
[2] Average, April to November, inclusive.

Double Filtration of Merrimack River Water with and without the Use of a Disinfectant. — Filters Nos. 331 and 286.

Filter No. 331, 1/80000 of an acre in area, containing 18 inches in depth of sand of an effective size of 0.45 millimeter, was first put into operation July 7, 1907. This filter was operated as a pre-filter at a rate of 100,000,000 gallons per acre daily until Dec. 1, 1908, when the rate was reduced to 50,000,000 gallons per acre daily, at which rate the filter continued to be operated during 1909. The canal water applied to this filter was first passed through a settling basin having a storage capacity of about five hours when the filter was operated at the higher rate, and double that capacity when operated at the lower rate. The entire body of sand was washed, just as if it had been a mechanical filter, twenty-three times during 1908 and fourteen times during 1909, the average quantity of water filtered between washings being about 1,413,000,000 gallons per

acre during 1908, and about 1,268,000,000 gallons per acre during 1909. The effluent from Filter No. 331 was collected and pumped into a storage tank, from which it was applied to Filter No. 286 throughout both years.

Filter No. 286, $\frac{1}{20000}$ of an acre in area, containing 4 feet in depth of sand of an effective size of 0.21 millimeter, was first put into operation Jan. 20, 1906. This filter has been operated as a secondary filter with the effluent from Filter No. 331 at a rate of 5,000,000 gallons per acre daily throughout 1908 and 1909. The surface of this filter was scraped eight times during 1908 and four times during 1909, the average quantity of water filtered between scrapings being about 178,000,000 gallons per acre during 1908 and about 373,000,000 gallons per acre during 1909. From Jan. 22 to Nov. 24, 1909, the filter was operated without any treatment of the surface, during which period a volume of water equivalent to about 1,280,000,000 gallons per acre was filtered. The net rate of the double filtration system was about 4,750,000 gallons per acre daily during 1908 and about 4,550,000 gallons per acre daily during 1909.

On Feb. 1, 1909, treatment of the effluent from the pre-filter with a small proportion of calcium hypochlorite was begun before that effluent was applied to the secondary filter. The strong solution of hypochlorite was added directly to the effluent as it entered a tank which had previously served as a rate controller and which was now made to serve also as a disinfection tank. On the average the water remained in this tank about thirty minutes, but, owing to the shape of the tank and the location of the inlet and outlet, some of the water probably passed through in much less time. From the rating box, the treated effluent flowed into a collection basin. It was pumped thence at intervals during the day to a storage tank, from which it was applied to the secondary filter.

From a chemical and physical point of view the effluent from this double filtration system was of about the same quality as that from single filters operated at about the same net rates. The color of the canal water was reduced about 7 per cent. and the albuminoid ammonia about 26 per cent. by the pre-filter, and about 37 per cent. of the color and 55 per cent. of the albuminoid ammonia were removed during the passage through both filters. The amount of nitrates in the water was more than doubled during filtration, and the free ammonia was decreased nearly 90 per cent.

The bacterial results divide themselves naturally into two periods, one of fourteen months of plain double filtration, and the other of ten months in which a disinfectant was introduced into the water in its passage from the primary to the secondary filter. During the first period the average removal of bacteria by the settling tank was about 43 per cent., but the average numbers of bacteria in the effluent from the pre-filter were

greater than in the water applied to it about one-third of the time. There was also a certain increase in the numbers of bacteria in the effluent from the pre-filter during its passage through the storage tank, before it was applied to the secondary filter. The average efficiency of the whole system was 97.9 per cent, figured from the room temperature counts, and about 92 per cent. figured from the counts of total numbers growing at body temperature. Over 28 per cent. of the samples of the effluent from the secondary filter contained B. coli in 1 cubic centimeter, 29 per cent. of these samples contained more than 100 bacteria per cubic centimeter and about 2 per cent. contained more than 1,000 bacteria per cubic centimeter. From these figures it is evident that the double filtration system failed, at least during a portion of the time, to produce an effluent which could be considered safe for drinking.

During the second or disinfection period the results of the passage of the canal water through the settling basin and pre-filter were substantially the same as during the first period just discussed. In February hypochlorite equivalent to 0.016 part per 100,000 available chlorine was added to the effluent from the pre-filter, the results being a reduction in bacteria to 200 per cubic centimeter as the water passed through the disinfection basin; that is, there was an average removal of about 91 per cent. While many of the samples of disinfected water were of satisfactory quality during this period, over 60 per cent. of the samples contained more than 100 bacteria per cubic centimeter. During March, April, May and June the amount of disinfectant added varied between 0.030 and 0.035 part available chlorine. During this period the numbers of bacteria before disinfection varied from less than 200 to about 2,300 per cubic centimeter, and the numbers after disinfection between 22 and 220 per cubic centimeter. During March and April the removal of bacteria averaged 86 per cent. and 76 per cent., respectively, 26 per cent. and 19 per cent., respectively, of the samples collected during these two months containing more than 100 bacteria per cubic centimeter, and 4 per cent. and 10 per cent., respectively, of the samples containing over 1,000 bacteria per cubic centimeter. Throughout May the effluent was of satisfactory quality, none of the samples containing as many as 100 bacteria per cubic centimeter, but owing to the small numbers of bacteria in the water before disinfection the average removal was only 86 per cent. During June the average removal of bacteria was 91 per cent., but 14 per cent. of the samples contained more than 100 bacteria per cubic centimeter. During July the proportion of disinfectant averaged 0.046 part per 100,000 available chlorine. The result was an average removal of 99 per cent. of the bacteria, none of the samples showing more than 100 bacteria per cubic centimeter. During August the amount of dis-

infectant used averaged 0.034 part per 100,000 available chlorine, the average removal of bacteria was 96 per cent., and 8 per cent. of the samples contained more than 100 bacteria per cubic centimeter. During September the proportion of hypochlorite was reduced to an equivalent of 0.023 part available chlorine, the average destruction of bacteria was 96 per cent., and 4 per cent. of the samples contained more than 100 bacteria per cubic centimeter. During October the proportion of disinfectant averaged 0.035 available chlorine, the average removal of bacteria was about 93 per cent., about 33 per cent. of the samples contained more than 100 bacteria per cubic centimeter, and nearly 10 per cent. of the samples contained more than 1,000 bacteria per cubic centimeter. In November the proportion of disinfectant was again reduced, the average amount applied being equivalent to 0.027 part available chlorine. The average removal of bacteria during November was over 96 per cent., or 4 per cent. better than during the preceding month, about 20 per cent. of the samples containing over 100 bacteria per cubic centimeter and about 5 per cent. more than 1,000 bacteria per cubic centimeter.

The removal of the types of bacteria growing at a body temperature was usually much less than the total bacterial removal, and many samples have been obtained in which the counts of bacteria growing at body temperature were higher than the room temperature counts. The occurrence and significance of this phenomenon has been discussed in the preceding pages. B. coli were found in 1 cubic centimeter in about 19 per cent. of the samples after disinfection, the figures for the different months varying from 5 per cent. during November to 40 per cent. during August.

It is evident from these results that disinfection of this effluent was not satisfactorily accomplished at all times by the small amounts of hypochlorites added, for, although a considerable proportion of the samples were of good bacterial quality, many samples were obtained which could not be considered safe for domestic use. Further experiments are in progress to determine the effect of treatment of the effluent from this filter with somewhat larger amounts of disinfectant.

Increase of Bacteria in Disinfected Water.

It has been previously stated that the bactericidal action of the hypochlorite is exhausted within a short time. This is illustrated by the fact that there was a large increase in the numbers of bacteria in the disinfected water during its passage through the collection and storage tanks before its application to the secondary filter. This increase, which was noted in practically all samples, varied from 100 to 7,500 per cent., and averaged about 670 per cent. There was also a small increase in the numbers of bacteria determined at body temperature in many samples,

although in the majority of instances the difference was so small as to be within the limits of error of the analytical methods. Previous to the use of hypochlorite, a similar increase in bacteria in the effluent of the pre-filter before its application to the secondary filter was noted, but the ratio of increase was very much less in the untreated water than in the disinfected water. The effluent from the secondary filter was of better quality bacterially during the filtration of the disinfected water than during the corresponding period of the preceding year, when it was operated with the untreated pre-filter effluent.

The results of the operation of these two filters during both periods are shown in the following tables. Analyses of the river water before filtration are shown on pages 223–225 and 226.

Average Bacterial Analyses.

Applied Water for Filter No. 331.

Period.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
	20° C.	40° C.		20° C.	40° C.		
		Total.	Red.		Total.	Red.	1 c. c.
Dec., 1907–Jan., 1909, .	4,400	115	79	43.1	7.2	2.5	98.6
Feb., 1909–Nov., 1909, .	2,100	73	42	57.2	40.2	35.4	92.6

Effluent of Filter No. 331.

Dec., 1907–Jan., 1909, .	4,600	97	68	4.5[1]	15.7	14.0	99.4
Feb., 1909–Nov., 1909, .	1,570	68	39	25.3	6.9	7.1	100.0

Effluent of Filter No. 286.

Dec., 1907–Jan., 1909, .	160	10	4	96.5	89.7	94.1	28.3
Feb., 1909–Nov., 1909, .	82	5	1	90.5	61.6	75.0	6.4

[1] Increase.

Average Chemical Analyses.

Effluent of Primary Filter No. 331.

[Parts per 100,000.]

Period.	Quantity Applied. Gallons per Acre Daily.	Temperature (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as— Nitrates.	Nitrogen as— Nitrites.	Oxygen Consumed.	Dissolved Oxygen (Per Cent. of Saturation).	Hardness.
Dec. 1907–Jan. 1909, .	91,993,600	54	0.1	.37	.0128	.0150	.43	.018	.0005	.50	69.0	1.0
Feb. 1909–Nov. 1909, .	50,841,500	58	0.2	.35	.0112	.0172	.49	.022	.0005	.53	44.6	1.1

Effluent of Secondary Filter No. 286.

Dec. 1907–Jan. 1909, .	4,935,600	56	0.0	.25	.0015	.0082	.41	.030	.0001	.41	58.2	1.0
Feb. 1909–Nov. 1909, .	5,163,700	57	0.0	.25	.0015	.0101	.50	.034	.0001	.40	54.5	1.1

Results of Disinfection of Effluent from Pre-filter No. 331.

Date.	Bleach (Grains per Gallon).	Chlorine (Parts per 100,000).	Cost per Million Gallons.	Bacteria per Cubic Centimeter. Before Disinfection. At Room Temperature.	Before Disinfection. At Body Temperature. Total.	Before Disinfection. At Body Temperature. Red.	After Disinfection. At Room Temperature.	After Disinfection. At Body Temperature. Total.	After Disinfection. At Body Temperature. Red.	After Disinfection. Per Cent. of 1 Cubic Centimeter Samples containing B. Coli.	Per Cent. of Bacteria Removed. At Room Temperature.	Per Cent. of Bacteria Removed. At Body Temperature. Total.	Per Cent. of Bacteria Removed. At Body Temperature. Red.
1909.													
February, . .	.025	.01	$0.04	2,300	53	25	200	26	6	16.7	91.3	51.0	76.0
March, . .	.055	.04	.10	1,300	35	20	185	19	6	21.7	85.8	45.7	70.0
April, . .	.047	.03	.08	900	24	13	220	11	5	14.3	75.6	54.2	61.6
May, . . .	.047	.03	.08	155	20	10	22	7	2	10.0	85.8	65.0	80.0
June, . . .	.049	.03	.09	1,260	90	44	110	6	2	14.3	91.3	93.3	95.5
July, . . .	.072	.05	.13	1,200	155	110	12	6	1	9.5	99.0	96.1	99.1
August, . .	.053	.03	.10	520	101	84	21	8	3	40.0	96.0	92.1	96.4
September, .	.036	.02	.06	630	33	22	23	8	3	31.8	96.3	75.8	86.4
October, . .	.054	.04	.10	6,200	150	50	450	10	4	23.8	92.7	93.3	92.0
November, .	.042	.03	.08	1,200	15	9	46	5	1	5.0	96.2	66.7	88.9
Average, . .	.048	.03	$0.09	1,570	68	39	130	11	3	18.7	91.7	83.8	92.3

Average Bacterial Analyses.

Date.	Applied for Filter 286. Bacteria per cubic centimeter. 20° C.	40° C. Total.	40° C. Red.	Per Cent. of 1 Cubic Centimeter Samples containing B. Coli.	Effluent Filter 286. Bacteria per cubic centimeter. 20° C.	40° C. Total.	40° C. Red.	Per Cent. of 1 Cubic Centimeter Samples containing B. Coli.	Per Cent. of Bacteria removed. 20° C.	40° C. Total.	40° C. Red.
1909.											
February,	1,500	28	7	16.7	180	11	2	5.5	88.0	60.7	71.5
March,	1,500	18	5	21.7	65	8	3	4.3	95.7	55.6	40.0
April,	1,000	11	3	12.5	60	5	2	6.3	94.0	54.6	33.3
May,	150	6	2	25.0	20	3	1	0.0	86.7	50.0	50.0
June,	470	36	5	20.0	18	4	1	10.0	96.2	88.9	80.0
July,	14	5	1	5.0	38	5	1	5.0	171.0[1]	0.0	0.0
August,	100	9	4	25.0	53	8	1	8.3	47.0	11.0	75.0
September,	70	5	2	26.1	16	3	1	4.3	77.2	40.0	50.0
October,	400	9	4	10.0	56	2	0	10.0	86.0	77.8	100.0
November,	3,440	5	2	25.0	310	3	1	10.0	91.0	40.0	50.0
Average,	865	13	4	18.7	82	5	1	6.4	90.5	61.6	75.0

[1] Increase.

Mechanical Filtration with Ferric Sulphate as a Coagulant.

Filter No. 339, 1/40000 of an acre in area, and constructed of 24 inches in depth of sand of an effective size of 0.23 millimeter, was started Feb. 27, 1908. This filter was operated as a mechanical filter at a rate of 10,000,000 gallons per acre daily. From Feb. 27 to April 30, 1908, canal water which had been treated with ferric sulphate in the proportion of 1½ to 2 grains per gallon and settled for about twenty-four hours was applied to this filter. Beginning May 1 and continuing until Sept. 30, 1908, canal water in which the color and organic matter had been increased by passing it through a tank containing peat was applied, after being treated with ferric sulphate in amounts varying from 4 to 6 grains per gallon, and allowed to settle twenty-four to thirty-six hours before passing to the filter. The experiments with river water indicate that a slightly less amount of ferric sulphate than of sulphate of alumina is required to ensure good coagulation. The principal advantage in its use is that with waters of low alkalinity, such as the Merrimack River water, the addition of soda ash or other alkali is not necessary. The ferric sulphate used in the experiments was made by the oxidation of ferrous sulphate with nitric acid, with the addition of the theoretical amount of sulphuric acid. Owing

to its unstable nature ferric sulphate is not a commercial product, but its production from copperas can be accomplished in the solution tanks at any mechanical filter plant without much difficulty. As made in the laboratory from sugar sulphate of iron ($FeSO_4 5H_2O$), and commercial nitric and sulphuric acids, the cost of ferric sulphate is about $33.80 per ton at the current prices of the raw materials in large lots. Made from sugar sulphate of iron, using commercial sodium nitrate and sulphuric acid instead of nitric acid, the cost of the ferric sulphate is about $27.50 per ton.

The results of the operation of Filter No. 339 are shown in the following tables: —

Average Chemical Analyses.

Effluent from Filter No. 339.[1]

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature. (Degrees F.).	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen Consumed.	Hardness.	Dissolved Oxygen (Per Cent. of Saturation).	Iron.
10,000,000	49	0.1	.14	.0061	.0064	–	.30	.020	.0006	.26	0.5	84.2	–
Raw Water for Filter No. 339.[2]													
–	67	0.1	.84	.0166	.0313	.0268	.40	.004	.0003	.87	1.2	–	.0850
Effluent from Filter No. 339.[2]													
10,000,000	68	0.0	.12	.0189	.0091	–	.40	.026	.0008	.22	0.2	28.2	.0356

[1] Operated with canal water. [2] Operated with peaty water.

Average Bacterial Analyses.

Effluent from Settling Basin Applied to Filter No. 339.[1]

Bacteria per Cubic Centimeter. 20° C.	Bacteria per Cubic Centimeter. 40° C. Total.	Bacteria per Cubic Centimeter. 40° C. Red.	Per Cent. of Bacteria removed. 20° C.	Per Cent. of Bacteria removed. 40° C. Total.	Per Cent. of Bacteria removed. 40° C. Red.	Per Cent. of Samples containing B. Coli. 1 c. c.
6,250	60	17	–	–	–	88.3
Effluent from Filter No. 339.[1]						
4,800	13	6	23.2	78.3	64.7	34.0

[1] Operated with canal water.

Average Bacterial Analyses — Concluded.

Raw Water for Filter No. 339.[1]

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
10,700	70	35	-	-	-	93.2
Effluent from Settling Basin Applied to Filter No. 339.[1]						
3,000	27	10	-	-	-	90.6
Effluent from Filter No. 339.[1]						
610	4	1	79.7	85.2	90.0	4.0

[1] Operated with peaty water.

Upward Filtration. — Filter No. 385.

In connection with an application to the Board for advice concerning a process of upward filtration, upward-flow Filter No. 385, 1/20000 of an acre in area, was put into operation Nov. 4, 1909. This filter was constructed as follows: upon a 1/4-inch mesh galvanized-iron wire screen, supported 1 foot above the floor of the tank, was placed 7 inches of pieces of wood charcoal between 1/4 and 1/2 inch in diameter. Resting upon the charcoal was a 1/8-inch mesh copper screen, above which was placed 24 inches in depth of sand of an effective size of 0.28 millimeter. Canal water was applied at the bottom, flowed up through the charcoal and sand, and passed off through an orifice 3 inches above the surface. As constructed, the maximum loss of head available was about 10 inches. The rate of filtration was 18,000,000 gallons per acre daily.

It was stated by the promoters of this type of filtration that, owing to the fact that suspended matters would be deposited in the sedimentation basin beneath the filter or in the charcoal layer, the filter could be operated for long periods at a small loss of head, and that when clogging eventually did occur it could readily be removed, and the filter restored to its original capacity by reversing the flow and allowing the water on the surface to flow back through the filter. It was further stated that a marked reduction in color would result from the use of the charcoal, and that the galvanic current generated between the copper and galvanized-iron screens would effectually destroy the bacteria in the water.

During the first three weeks the time during which the filter could be operated without washing rapidly decreased, until on November 26 less than one day's normal flow could be obtained between washings. The time required for washing, by allowing the filtered water on the surface to flow back through the filter, increased during this period from about two and one-half hours to about twelve hours, and at the end of the period there was no improvement in the loss of head as the result of washing by this method.

Attempts were made to continue the filter in operation by washing the material by a strong upward flow of water, as is done with mechanical filters. While some relief was at first obtained by this process, the clogging continued to increase, and the quantity of water filtered between washings to decrease, until by the middle of December less than 10,000,000 gallons per acre daily could be obtained between cleanings.

As the filter could not be kept in operation as designed by washing with reversed flow, nor by washing with water under pressure, and as very little purification of the water was being accomplished, the filter was discontinued Dec. 18, 1909.

It is evident from this experiment that the upward filtration of water under the conditions stated is impracticable, for the reason that the suspended matters clog the filtering material at the bottom, where the clogged layer is inaccessible and its removal by washing is difficult. The use of charcoal does not appear to have any appreciable advantage over other materials for effecting the removal of color from such waters as the Merrimack River, as was proved not only by the operation of this filter but by numerous experiments made in the laboratory. As to the efficiency of the electric couple, formed by the copper and zinc netting, the slight current generated by such means could not be expected to have any marked bactericidal effect, and this was demonstrated by the bacterial results obtained with this filter.

Average Chemical Analysis.

Filter No. 385.

[Parts per 100,000.]

Appearance.				Ammonia.			Nitrogen as—			
Turbidity.	Sediment.	Odor.	Color.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
0.1	0.0	v. sl.	.23	.0290	.0196	.60	.014	.0008	.57	1.6

Average Bacterial Analysis.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	40° C.		20° C.	40° C.		
	Total.	Red.		Total.	Red.	1 c. c.
1,750	16	9	69.0	70.4	73.6	51.7

Studies upon the Removal of Color and Bacteria from Water by Means of Trickling Filters.

Filters Nos. 365 and 366.

Filters Nos. 365 and 366, 1/80000 of an acre in area, and constructed of 10 feet in depth of broken stone pebbles having an effective size of 4.4 millimeters, were first put into operation Nov. 19, 1908. These filters were operated like trickling filters in the purification of sewage. The canal water was applied to the surface by means of a perforated pan and tipping basin and the rates so adjusted to the material that the filter contained a mixture of air and water, a free circulation of air being obtained through openings at the sides and bottom of the filter. Both filters were operated at rates of 3,000,000 gallons per acre daily except during the period from May 10 to June 21, 1909, when the rates were reduced to 1,500,000 gallons per acre daily.

From November 19 to March 26 canal water which had been treated with chlorine water in the proportion of about 1 part chlorine per 100,000 was applied to Filter No. 365. During this period no color removal was obtained as a result of the chlorine treatment, and the removal of color during filtration was only about 5 per cent. Beginning March 27 and continuing until October 2 the treatment with chlorine was omitted, and ammonium chloride in amounts equivalent to 0.37 to 0.74 part nitrogen per 100,000 was mixed with the applied water. Following this change nitrification commenced in the filter, and the removal of color increased, the average nitrates in the effluent during the second period being 0.308 part per 100,000, and the average color removal being about 22 per cent.

From November 19 to May 2 Filter No. 366 was operated with untreated canal water. The removal of the color averaged about 9 per cent. during this period. From May 3 to June 6 the organic matter in the applied water was increased by the addition of pepton, equivalent to about 0.72 part nitrogen per 100,000. Nitrification began almost immediately, and the removal of color during this period increased to 44 per cent. From June 7 to July 5 the filter was again operated with un-

treated canal water. From July 6 to September 21 nitrogen as potassium nitrate, in amounts varying from 0.32 to 0.93 part per 100,000, was added to the applied water for this filter, and from September 21 to October 4 potassium chlorate was added in the proportion of 0.2 part per 100,000. So far as could be observed these later changes in the character of the applied water produced little effect upon the results of filtration. Nitrification continued active, and the removal of color was extremely satisfactory, varying from over 57 per cent. to about 38 per cent.

While these two filters were operated primarily as a study of color removal, the bacterial results are also of interest. During the period when the applied water for Filter No. 365 was treated with chlorine there was a reduction in the bacterial content of the raw water of over 88 per cent., but the filter effluent contained larger numbers of bacteria than did the canal water before treatment. During the second period, when ammonium chloride was added to the applied water and nitrification became established in the filter, about 95 per cent. of the bacteria were removed during filtration. When Filter No. 366 was operated with untreated canal water about 75 per cent. of the bacteria were removed. With the addition of pepton, at first the total numbers of bacteria in the effluent increased, but with the beginning of nitrification the bacterial counts steadily decreased, and during July, August and September the bacterial efficiency of this filter was over 99.7 per cent., and the effluent compared favorably, from a bacterial standpoint, with the best slow sand filter effluents. This bacterial efficiency was obtained, it must be noted, by bacterial action alone, without the straining effect occurring with sand filters.

The average results of the operation of these two filters during the different periods are shown in the following tables: —

Removal of Color and Bacteria by Filters Nos. 365 and 366.

Applied Water for Filter No. 365.

Period.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Color Removed.
	20° C.	40° C.		20° C.	40° C.		
		Total.	Red.		Total.	Red.	
Nov. 19, 1908–March 26, 1909, . .	670	20	4	88.3	72.6	87.1	0.0
Effluent of Filter No. 365.							
Nov. 19, 1908–March 26, 1909, . .	6,200	20	5	–	–	–	5.5
March 27, 1909–Oct. 2, 1909, . .	210	5	4	94.9	96.3	94.1	22.2

Removal of Color and Bacteria by Filters Nos. 365 and 366 — Concluded.

Effluent of Filter No. 366.

Period.	Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Color Removed.
	20° C.	40° C.		20° C.	40° C.		
		Total.	Red.		Total.	Red.	
Nov. 19, 1908–May 2, 1909,	1,310	24	7	75.3	66.2	77.4	8.6
May 3, 1909–June 6, 1909,	1,060	4	2	33.7	93.7	93.3	44.0
June 7, 1909–July 5, 1909,	68	6	2	99.1	97.7	98.5	57.2
July 6, 1909–Sept. 20, 1909,	10	1	0	99.7	99.3	100.0	51.5
Sept. 21, 1909–Oct. 4, 1909,	35	5	2	99.7	98.2	99.1	37.5

Average Chemical Analyses.

Effluent of Filter No. 365.

[Parts per 100,000.]

Period.	Appearance.		Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Hardness.
	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
Nov. 19, 1908–March 26, 1909,	0.2	.33	.0112	.0146	0.79	.028	.0006	.58	0.9
March 27, 1909–Oct. 2, 1909,	0.0	.26	.2134	.0147	2.09	.308	.0004	.29	0.2

Effluent of Filter No. 366.

Nov. 19, 1908–May 2, 1909,	0.1	.32	.0099	.0130	0.41	.029	.0004	.53	0.8
May 3, 1909–June 6, 1909,	0.1	.28	.2238	.0219	0.28	.290	.0014	.25	1.2
June 7, 1909–July 5, 1909,	0.0	.18	.0046	.0137	0.31	.280	.0001	.43	0.9
July 6, 1909–Sept. 20, 1909,	0.0	.16	.0008	.0091	0.55	.590	.0001	.36	1.9
Sept. 21, 1909–Oct. 4, 1909,	0.0	.20	.0008	.0098	0.72	.049	.0046	.61	1.6

Disposal and Purification

of

Factory Wastes or Manufacturing Sewage.

By H. W. Clark, *Chemist to the Board.*

Disposal and Purification of Factory Wastes or Manufacturing Sewage.

By H. W. Clark, *Chemist to the Board.*

The disposal and purification of manufactural wastes has been the subject of much investigation by the State Board of Health of Massachusetts during the past fifteen years, both at the Lawrence Experiment Station and at certain industrial establishments in the State. The nature of these wastes has been varied, including those from tanneries, woolen factories, paper mills, dye works, creameries, binders' board works, yeast factories, carpet works, batting works, silk mills, gas works, bleacheries, shoddy mills, glue works, paint mills, etc. As a result of these investigations practical and satisfactory methods for the disposal of many of these wastes have been developed, and at the present time a number of purification plants are in operation or under construction in Massachusetts. The subject is a broad one, and many difficulties have been encountered that are absent from the problem involved in the disposal of domestic sewage, and which, oftentimes, prevent a general application of the results obtained. The chief difficulties are (1) the nature of the waste liquor in some manufacturing processes whereby purification by bacterial action or nitrification is prevented; (2) the excessive amount of solid matter per unit volume of liquor, especially carbonaceous matter, — often many times as great as that found in the strongest domestic sewage; (3) the enormous volume of liquor used in many industries, which liquor comes from such plants loaded with organic matter and chemicals of many kinds; (4) the varying character of the liquor coming from different manufacturing plants doing similar work, — a fact which prevents the experimental data from being universally applicable; and (5) the liability to change, from time to time, in the processes carried on in any industrial plant.

Wastes from Tanneries.[1]

Tannery A.

During the past fourteen years the wastes from three tanneries have been experimented upon. The first tannery investigated was engaged in preparing and tanning sheep skins. The daily volume of the waste varied from 20,000 to 50,000 gallons, and was composed of a thick, offensive liquor varying in color as different aniline dyes were used. The amount of organic matter present was large and in an advanced state of putrefaction. It seldom contained any substance of a character to check bacterial action and was, therefore, easily nitrified. The sludge was at times great in volume and rich in fats and nitrogenous matters. A filter was constructed at this tannery, containing 2 feet in depth of sand of an effective size of 0.14 millimeter, over gravel underdrains; and sewage, made up of a mixture of the waste liquors from all the processes carried on at the tannery, was first applied to it on Sept. 27, 1895, at an average rate of 55,000 gallons per acre daily. During a large part of its period of operation, however, the rate was 25,000 gallons per acre daily, but even at this rate the filter became clogged quickly by matter in suspension in the waste.

The following analyses show the character of the liquor as applied to and of the effluent from this filter during its period of operation: —

Average Analysis of Liquor applied to Filter.

[Parts per 100,000.]

Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as —		Oxygen Consumed.
Free.	Albuminoid.						
	Total.	In Solution.			Nitrates.	Nitrites.	
3.74	3.16	1.91	5.92	387.20	.16	.0015	61.25

Average Analysis of Effluent from Filter.

2.65	0.48	0.20	0.69	284.25	.60	.0068	7.92

It was evident that better nitrification and higher rates of filtration could be obtained if suspended matter was removed from the sewage before filtration.

[1] In some instances, the filters as described in the various annual reports in connection with the purification of manufactural wastes, bear different numbers than in this review. The numbers given here are for the sake of clearness and to prevent confusion.

Precipitation with Lime. — In one of the processes at the tannery a large amount of lime was used, and milk of lime was being mixed almost continuously with the rest of the waste. Experiments soon showed that 60 per cent. of the organic matter could be removed by sedimentation with the aid of this lime waste. The resulting supernatant liquor, still very rich in organic matter in solution, was first applied in January, 1896, to a filter $\frac{1}{20000}$ of an acre in area and containing 4 feet in depth of sand of an effective size of 0.14 millimeter. This filter was located in a building in which the temperature was but slightly above the freezing point during the winter, and, because of this low temperature, nitrification did not become active until the approach of warm weather. The waste was applied for four months at the rate of 120,000 gallons per acre daily, but this rate was found to be excessive for so strong a sewage, and was reduced to 60,000 and then to 30,000 gallons per acre daily. Nitrification began in May, 1896, and the filter was continued in operation until September, 1898. Nitrification continued active; the effluent from the filter was clear and colorless, and when the filter was discontinued it was working satisfactorily, and gave promise of doing so indefinitely.

The following table gives the average analysis of the liquor applied to and of the effluent from this filter: —

Average Analysis of Tannery Sewage applied to Filter.

[Parts per 100,000.]

Ammonia.			Chlorine.	Nitrogen as —		Oxygen Consumed.	Fats.
Free.	Albuminoid.						
	Total.	In Solution.		Nitrates.	Nitrites.		
6.82	2.39	1.83	375	0.17	.0112	46.66	8.97
Average Analysis of Effluent from Filter.							
1.45	0.23	0.12	405	9.96	.0258	1.79	6.00

A third filter, constructed of 4 feet in depth of sand and receiving a mixture of the tannery liquor and domestic sewage, was kept in operation from June, 1896, until the beginning of 1898. During most of this period the mixture had the proportions of 1 part tannery liquor to 2 parts sewage, and was applied to the filter at rates between 40,000 and 50,000 gallons per acre daily, with satisfactory purification.

Coke Strainer. — A coke strainer, containing 2 feet in depth of coke, the upper portion being coke breeze and the lower portion coarser coke,

was started at the tannery in December, 1896, and continued in operation until October, 1898. Operating at rates varying from 250,000 to 300,000 gallons per acre daily, it was successful in removing about 85 per cent. of the crude organic matters in the applied sewage, represented by the determinations of albuminoid ammonia, and 83 per cent. of those represented by the determinations of oxygen consumed. The effluent from the strainer even after the removal of this large amount of organic matter was fully as strong as ordinary city sewage, but could be purified easily at a high rate upon ordinary sand filters. Some nitrification occurred in the strainer, and its effluent was often fairly clear and of a color easily read upon the color standards used at Lawrence, while the applied sewage was always highly colored, either black, red or brown, according to the nature of the work being carried on in the tannery. Sludge was removed from the surface of the strainer several times. This sludge could be disposed of readily on a large scale by burning under boilers, especially as it contained considerable fat in addition to the coke which was removed with the deposit on the filter.

The average analysis of the tannery sewage applied to and of the effluent from the coke strainer follow: —

Average Analysis of Liquor applied to Coke Strainer.

[Parts per 100,000.]

Ammonia.			Nitrogen as —		Oxygen Consumed.	Fats.
Free.	Albuminoid.					
	Total.	In Solution.	Nitrates.	Nitrites.		
4.04	4.45	2.54	-	-	95.20	22.70

Average Analysis of Effluent from Coke Strainer.

1.90	0.35	0.20	.56	.0151	3.96	3.07

The investigations made with the wastes from this tannery are described in the report of the Board for 1895, pp. 471 and 472; report for 1896, pp. 433–438, inclusive; report for 1897, pp. 397 and 398; report for 1898, pp. 463–465, inclusive.

Tannery B.

Experiments upon the filtration of wastes from a tannery engaged in preparing and tanning calf skins were made during 1896 and 1897. The volume of liquor flowing from the tannery exceeded 200,000 gallons per day. It was a thick, offensive liquor containing a very large

amount of organic matter, and was generally colored by dyestuffs. Some of the skins were imported, and came packed in a germicide to prevent decomposition; and this germicide, largely naphthalene, was present in the sewage throughout the period of examination. The waste liquor also always contained arsenic both in suspension and in solution, inasmuch as a ton or more of sulphide of arsenic was mixed with the lime each month to help free the skins of hair. A large amount of the organic matter was present in suspension, and experiments showed that it would settle out from the main body of sewage very completely in one hour, with the aid of the lime and other chemicals present. A considerable portion of the arsenic was held by the organic matter in suspension and was carried down with it, but the supernatant sewage after sedimentation contained generally enough arsenic to check bacterial growth. This supernatant sewage was applied to a sand filter and a coke strainer at average rates of 50,000 and 100,000 gallons per acre daily, respectively, and the effluent from the coke strainer was applied to another sand filter at the latter rate.

The first filter (No. 71), containing 4.5 feet in depth of sand, produced a satisfactory effluent generally, but nitrification ceased entirely when the applied sewage contained more arsenic than usual. Operated at a rate of 100,000 gallons per acre daily, the coke strainer (No. 72), containing 2 feet in depth of coke breeze, had its surface covered for about two hours daily. It removed considerable organic matter and generally all the arsenic from the sewage. When the sewage applied to this coke strainer contained so much arsenic that only a few hundred bacteria were found growing in it, its effluent contained several million bacteria per cubic centimeter. The second sand filter (No. 73), constructed of 4.5 feet in depth of sand and receiving the effluent from the coke strainer at a rate of 100,000 gallons per acre daily, maintained uniformly good nitrification and purification.

The following table gives the average analysis of the sewage applied to and of the effluent from each of these three filters: —

[Parts per 100,000.]

	Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.		Nitrates.	Nitrites.		
Sewage applied,	1.09	4.70	43.00	0.00	.0000	40.50	-
Effluent from Filter No. 71,	2.36	0.61	44.96	0.74	.0313	10.12	589,260
Effluent from Filter No. 72,	2.76	0.77	39.81	0.12	.0249	10.57	437,000
Effluent from Filter No. 73,	0.42	0.11	43.41	1.97	.0167	3.52	87,600

Removal of Arsenic by Coke and Iron. — Methods for removing the arsenic from this tannery sewage were studied, and it was found, as stated previously, that by passing the sewage through a filter or strainer of coke breeze it was quite thoroughly freed from arsenic. This removal was due probably to the presence of iron in the coke, since the same result was accomplished by passing the sewage through iron filings or turnings.

Average Amount of Arsenic (As_2O_3) in Entire and Supernatant Sewage, and Effluent from Coke Strainer.

[Parts per 100,000.]

Entire tannery sewage,	8.5447
Supernatant tannery sewage,	1.6757
Effluent from coke strainer,	0.0823

Generally speaking, the effluent from the coke strainer was free from arsenic, but occasionally, if an excessive amount was applied and if the strainer was overworked, some arsenic would pass through. Examination of the coke proved that a large percentage of the arsenic was retained in the upper few inches of the strainer. For example, a small strainer containing 2 feet in depth of coke breeze was flooded each day for two weeks with this sewage. The effluent examined each day was found to be free from arsenic. On October 15 the coke itself was examined, with the following results: —

Arsenic as As_2O_3.

[Parts per 100,000.]

Upper 4 inches of coke,	36.40
Middle 4 inches of coke,	6.60
Lower 4 inches of coke,	0.20

The investigations upon the wastes from this tannery are fully described in the report of the Board for 1896, pp. 431–433; and in the report for 1897, pp. 396 and 397.

Tannery C.

In 1900 an application was received by the Board from a tannery, asking advice as regards the improvement of its wastes and stating that for years a system of settling basins had been maintained at considerable expense. The following conditions were found to obtain at this tannery: the chief waste liquors were those from the processes of wool-scouring, skin-washing, tanning, dyeing and the drainage from the water-closets used by about 300 employees, all of these wastes passing to the settling basins. The water used in the last bowl of the wool-scouring machine was discharged into a stream in wet weather, but when the flow was small this water was

used for skin-washing. The wool after being scoured was rinsed in rinsing machines, which used a great quantity of water, — about 500,000 gallons per day. The most objectionable waste was the drainage from the glue-stock washer. This was a cylindrical tank 17 feet in diameter, located in the floor of the skin-washing room, but at so low an elevation that it could not be connected with the main drain leading to the settling basins. The waste from the process of glue-stock washing amounted to about 22,000 gallons a day, and contained lime and dirt from the skins, and, on alternate days, sulphuric acid. Measurements of the flow of sewage and also of the water flowing out of the settling basins were made, the amounts of the latter being on four different days, — namely, October 8, November 12, November 22 and November 25, — 322,000, 400,000, 370,000 and 350,000 gallons, respectively.

Two small sand filters, each containing 5 feet in depth of sand of an effective size of 0.24 millimeter, were put into operation. The waste liquor resulting from the preparation of hides for tanning was applied to Filter No. 1, and to Filter No. 2 the waste liquor from certain processes necessary in tanning hides, together with considerable wool-scouring liquor. Both filters were continued in operation for three months at a rate of 63,000 gallons per acre daily, producing well-purified effluents with but little odor, the results thus showing that the sewage from both drains at the tannery could be purified easily upon sand filters. Following this, the sewage from both drains was applied to Filter No. 1 at an average rate of 83,500 gallons per acre daily for two months. By mixing these sewages and applying both to one filter the effluent was caused to be considerably higher in color, and nitrification became more active after the application of the mixed sewage than before.

From 1901 to 1904 the waste from this tannery increased materially, 434,000 gallons being the daily volume at the time measurements were made during the latter year. The quantity of wet sludge removed by the crude settling tanks at the tannery in 1901 was estimated to be about 3,700 cubic feet, and better settling basins would probably have removed a larger quantity.

Experiments made at Lawrence in 1904 indicated, in confirmation of earlier experiments with this waste, that it might be practicable to purify this tannery sewage upon sand filters operated at a rate as great as 80,000 gallons per acre daily.

In September, 1907, further investigations of the wastes from this tannery were carried on at the experiment station, and filters were again put into operation, to which were applied the wastes from the outlets of the settling tanks. The process of tanning at the works at this time was found to be about as follows: the hides were first steamed and soaked in order to

make them soft, then the inside of the skin was painted over its entire surface with a decoction containing arsenic. The skins were then folded with the painted surface inside and allowed to remain over night in a warm atmosphere and "sweated." The arsenic so affected the hide that the hair could be easily removed. The skins were then washed. The waste water contained practically all the arsenic, but this was mixed with the entire volume of waste liquors which flowed from the tannery. It was suspected that the arsenic in the waste liquors might prevent nitrification and therefore good purification by filtration.

A filter (No. 332), containing 4 feet in depth of sand of an effective size of 0.25 millimeter, was put into operation at a rate of 75,000 gallons per acre daily. The waste as received at the station was applied until November, when the effluent of the contact filter (No. 334), constructed of 2 feet in depth of coke breeze and iron turnings (1 part of iron to 9 parts of coke), was applied to it. This filter was operated with the waste as received at a rate of 250,000 gallons per acre daily, two hours' contact being allowed. Nitrification did not occur to any great extent in the sand filter until the effluent of the contact filter was applied. The beginning of nitrification at this time was probably a coincidence, however, as other experiments seemed to show that nitrification would have started without the preliminary treatment in the contact filter. Nitrites, furthermore, had been very high in the effluent of the sand filter at times previous to the application of the effluent of the contact filter. The amount of arsenic in the waste liquors was not large, the average in many samples examined being only 0.13 part per 100,000, and of this, the contact filter removed practically 54 per cent.

Another filter (No. 333) was started in November, 1907, of the same size and depth of sand as the filter just mentioned. It was operated at a rate of 75,000 gallons per acre daily at first and then at 100,000 gallons per acre daily, the dose applied to this filter being equal parts of Lawrence sewage and tannery waste. Nitrification was active until the rate was changed, when it became much poorer. In addition to these filters, a sand filter (No. 335) was operated with Lawrence sewage to which arsenic was added. The sewage at first contained 0.01 of a part of arsenic and the amount was increased each week until the arsenic applied equaled 50 parts per 100,000. The effluent from the filter contained about 6 per cent. of the arsenic in the applied sewage. The following February the sand from the surface of the filter contained 1.2 parts arsenic per 100,000, and sand at a depth of 6 inches, 0.6 part arsenic.

The following table gives the average analysis of the effluent from each of these four filters:—

Average Analysis of Effluent from Filter No. 332.

[Parts per 100,000.]

Color.	Ammonia.		Nitrogen as —		Oxygen Consumed.	Arsenic.	Hardness.
	Free.	Albuminoid.	Nitrates.	Nitrites.			
.17	2.2524	.0735	2.31	.5722	.51	.03	18.5

Average Analysis of Effluent from Filter No. 333.

.11	3.6720	.0760	0.96	.0778	.45	.01	15.0

Average Analysis of Effluent from Filter No. 334.

–	2.5781	1.5631	0.08	.0478	8.58	.06	24.7

Average Analysis of Effluent from Filter No. 335.

[Parts per 100,000.]

Color.	Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Arsenic.		Hardness.
	Free.	Albuminoid.		Nitrates.	Nitrites.		Applied.	Effluent.	
.10	.2841	.0371	11.30	5.59	.0014	.26	.33	.02	—0.2

From the above experiments it seemed probable that good sand filters receiving the sewage from the outlet of the settling tanks at the tannery would, if operated at reasonable rates, produce good nitrification even with considerable arsenic in this waste, but that some arsenic would accumulate in the upper layers of the sand; that it would be best to pass the sewage, after sedimentation, through filters of coke breeze for partial purification and for the removal of a considerable percentage of arsenic before passing the sewage to sand filters.

During 1909 filters were again operated with waste from this tannery. The first filter, containing 3½ feet in depth of sand, was operated at rates varying from 50,000 to 150,000 gallons per acre daily, producing an effluent which was odorless and but slightly turbid.

A Trickling Filter receiving Tannery Sewage. — A second filter, containing 6 feet in depth of broken stone, was started in May, 1909, and was operated at rates varying from 500,000 to 1,500,000 gallons per acre daily, and a well-nitrified, stable and practically odorless effluent resulted. The supernatant liquor after a short period of standing was

clear, and the sediment was as stable as the characteristic sediment of all good trickling filters. The average analysis of the effluent from this filter was as follows: —

[Parts per 100,000.]

Color.	Ammonia.		Nitrogen as —		Oxygen Consumed.
	Free.	Albuminoid.	Nitrates.	Nitrites.	
1.18	1.48	.39	2.54	.085	4.27

In June the effluent from this filter was applied to a sand filter 3½ feet in depth and operated at a rate of 150,000 gallons per acre daily. This latter filter produced an effluent with the following average analysis: —

[Parts per 100,000.]

Color.	Ammonia.		Nitrogen as —		Oxygen Consumed.
	Free.	Albuminoid.	Nitrates.	Nitrites.	
0.61	0.48	.10	3.60	.029	0.92

All these filters were kept in operation without difficulty and were in good condition at the end of the experiment. The matter in suspension separated more easily in warm weather than during the colder portion of the year, but during the entire period of operation the filters did not cease to give good nitrification.

Waste Liquors from Scouring and Washing Wool.

The liquor resulting from scouring and washing wool by the old-fashioned methods, which are still quite common in Massachusetts mills, is large in volume and exceedingly rich in mineral and organic matters, both in solution and suspension, and of a nature not readily acted upon by the bacterial agencies of putrefaction, decomposition and nitrification. Since 1895 studies have been made by the Board of the wastes from a number of large plants where this work is carried on. Many measurements of the volume of water used per gallon of wool scoured and washed have been made, and also many estimates of the amount of dirt contained in these liquors. Some of these measurements follow. The differences are due either to the varying quality of wool washed or to variations in the manner of operation, depending upon the degree of cleanliness required of the wool.

Plant No. 1. — Sixty-seven thousand gallons of water per day used per 42,000 pounds of wool scoured; 2,144 pounds of solid matter discharged in each 12,000 gallons of waste; 1.6 gallons of water per pound of wool scoured.

Plant No. 2. — Seventy-three hundred gallons of water per day used per 23,300 pounds of wool scoured, or 3.2 pounds per gallon of water; 7,415 pounds of solid matter per 12,000 gallons of waste.

Plant No. 3. — Twenty thousand gallons of water per day used; 9,281 pounds of solid matter per 12,000 gallons of waste.

Plant No. 4. — Thirty-seven thousand gallons of water per day used per 10,000 pounds of wool scoured, or 3.7 gallons per pound of wool; 54 gallons of water per pound of wool used in addition for washing the wool after scouring; 4,500 pounds of solid matter per 12,000 gallons of waste.

Plant No. 5. — Sixty-eight gallons of water used per pound of wool scoured and washed; 25,000,000 pounds of wool scoured per year.

Plant No. 6. — One hundred and fourteen thousand pounds of wool scoured per day; 0.56 of a gallon of water used per pound of wool scoured.

Filtration.

Experiments in 1895, 1896 and 1897 on the filtration of various wool wastes all resulted in failure when wool liquor alone was applied to the filter. This was to be expected owing to the general character of the wastes. Only when these wastes were mixed with large volumes of domestic sewage could they be successfully treated by intermittent filtration. When applied directly to sand or coke filters these wastes quickly clogged the surface, and the effluent did not differ in its general character from the applied waste. When clarified by various chemicals the liquor passed through the filters readily, but still remained practically unchanged. In fact, when applied in any considerable volume to a filter which was receiving domestic sewage, and which was in a state of active nitrification, it quickly checked this action. Filtration results were as follows: —

Filter No. 61. — This filter was $1/20000$ of an acre in area, and contained over the usual underdrains 60 inches in depth of sand of an effective size of 0.25 millimeter. The waste liquor from scouring wool was applied at an average rate of 17,000 gallons per acre daily. The results showed that while this liquor could be filtered through sand at this rate and a large percentage of its organic matters removed, yet the filter was operated with difficulty, owing to constant clogging, and a removal of the surface layers of sand was necessary repeatedly.

Average Analysis of Liquor applied to Filter No. 61.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
Free.	Albuminoid.		Nitrates.	Nitrites.		
17.30	43.10	60.13	.0000	.0000	232.00	–

Average Analysis of Effluent from Filter No. 61.

27.80	8.30	47.00	.2800	.0000	90.00	30,000,000

Filters Nos. VI. and VII. — Filter No. VI. contained 60 inches in depth of sand of an effective size of 0.25 millimeter, and Filter No. VII. contained the same depth of coke breeze. To these two filters the effluent from Filter No. 61 was applied at an average rate of 50,000 gallons per acre daily. Each filter disposed of the applied liquor readily, but it passed through the 5 feet of filtering material with very little or no change.

Average Analysis of Effluent from Filter No. VI.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
Free.	Albuminoid.		Nitrates.	Nitrites.		
19.58	7.90	72.23	.2260	.0012	76.60	728,000

Average Analysis of Effluent from Filter No. VII.

21.17	8.39	54.06	.2200	.0260	76.10	472,000

Filter No. VIII. — This filter contained 5 feet in depth of sand of an effective size of 0.25 millimeter, and to it was applied the supernatant liquor resulting from removing much fat and dirt from the strong waste wool-scouring liquor when using calcium chloride as a precipitant. This treatment with calcium chloride gave an almost complete clarification of the liquor, and its strength after treatment, estimated by albuminoid ammonia determinations, was about the same as that of the effluent from Filter No. 61. Filter No. VIII. disposed of this clarified liquor readily at an average rate of 100,000 gallons per acre daily, but it passed through 5 feet of sand with very little change.

Average Analysis of Effluent from Filter No. VIII.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
Free.	Albuminoid.		Nitrates.	Nitrites.		
11.19	6.54	65.00	.1510	.0953	53.63	720,000

Analyses of Waste Liquor from a Second Plant. — Some complete analyses of waste liquor from a plant at which the liquor was more dilute than at Plant No. 1 resulted as follows: —

Analyses of Wool-scouring Liquor.

[Parts per 100,000.]

Residue on Evaporation.			Ammonia.				Chlorine.	Oxygen Consumed.
			Free.	Albuminoid.				
Total.	Loss on Ignition.	Fixed.		Total.	In Solution.	In Suspension.		
1,488	718	770	10.27	6.76	-	-	-	120.0
1,696	1,103	593	6.10	12.07	5.88	6.19	25.56	136.0

Filtration of Waste Wool Liquors from a Third and Fourth Plant. — An experiment was made upon the filtration of the entire waste flowing from a third plant, this waste including not only the liquor from scouring but also that from washing and rinsing. The filter contained 4½ feet in depth of sand of an effective size of 0.23 millimeter, but the waste passed through without nitrification. Afterwards, a small portion of city sewage, about one-fifth of the total volume of liquor applied to the filter, was added to the waste; nitrification became quickly established and the character of the effluent became much improved. It was possible to operate this filter at a rate exceeding 200,000 gallons per acre daily and still obtain a well-oxidized effluent. It was continued in operation for two years; then waste-scouring and washing liquor from a different establishment was mixed with the sewage and applied. It was still successful in causing purification. During the first three months of 1898 the filter was operated at a rate of 400,000 gallons per acre daily, the average analysis of the applied liquor and of the effluent being as follows: —

Average Analysis of Applied Liquor.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.
Free.	Albuminoid.		Nitrates.	Nitrites.	
1.95	.55	4.75	-	-	3.05

Average Analysis of Effluent.

0.44	.03	4.88	1.00	-	0.40

After this, the applied liquor was so changed that the mixture consisted of a strong *scouring* liquor mixed with city sewage, in the proportion of 1 part liquor to 17 parts sewage, and the rate of operation of the filter was reduced to 55,600 gallons per acre daily. The average analyses of the liquor applied to and of the effluent from this filter during the ensuing four months follow: —

[Parts per 100,000.]

	Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
Applied liquor,	4.10	2.15	9.76	-	-	19.62
Effluent,	2.37	1.02	9.61	.57	.0550	12.50

It will be seen that the character of the effluent of the filter deteriorated very decidedly during this period, although it was clear and almost colorless.

Application of Rotted Wool-Liquor. — During this period a sand filter of the same depth and grade of sand as the filter just mentioned was in operation. It received the same grade of mixed liquor at the same rate, but before application the mixture was allowed to stand forty-eight hours for anaerobic bacterial or rotting action to occur. The effluent from this filter was of a much better character, showing that the bacterial action which took place before application, like that which occurs in a septic tank, broke down the organic matter of the wool waste to such a degree that it was more easily nitrified.

Effluent from Filter receiving Rotted Liquor.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.
Free.	Albuminoid.		Nitrates.	Nitrites.	
.0694	.1134	7.30	3.75	.0075	1.66

Sedimentation.

When wool-scouring liquors are allowed to run into settling tanks, a considerable portion of the matter in suspension, such as sand, mineral matter, etc., washed from the wool, settles out. It is probably true, judging from our experiments, that in no case will more than 30 per cent. of the organic matter in suspension settle out within any reasonable length of time. Generally the percentage is not as large as this, inasmuch as the soapy and fatty matters present have a tendency to float and to hold up other matters in suspension.

Chemical Precipitation.

In the experimental treatment of these wool wastes about all the common precipitants were used, such as lime, ferric sulphate, ferric sulphate and lime, iron alum, aluminum sulphate, ferrous sulphate, ferric chloride, calcium chloride, etc. In all these experiments it was shown that a large amount of precipitant was needed to cause any coagulation whatever. Varying amounts of alum up to 30,000 pounds per million gallons often had little effect, and the same can be said of the addition of ferric sulphate. When ferric sulphate and lime were both added the amount necessary to cause a fair coagulation and precipitation was somewhat less. Treatment of some of these wastes with sulphate of alumina, at the rate of 50,000 pounds per million gallons, caused no precipitation beyond that given by sedimentation alone. With ferrous sulphate and ferric chloride some precipitation could be obtained by using 15,000 pounds per million gallons. Calcium chloride was more efficient than any of the other precipitants, but at least from 10,000 to 20,000 pounds per million gallons had to be used with a strong liquor. In the use of this precipitant the filtrate after precipitation was generally almost odorless.

The failure of precipitants to cause any satisfactory coagulation and precipitation of wool-scouring liquor, except when added in excessive amounts, is due to a number of causes. Inasmuch as the amount of

organic and mineral matter present in the liquor is often from one hundred to three hundred times as great as is seen in ordinary domestic sewage, the necessity for an excessive use of precipitants is to be expected. There is, too, the difficulty due to the large amount of dirt. Much of the fatty matter in the liquor, furthermore, is in a state of semi-emulsion, and lighter than the water in which it is held; hence, any coagulation tends to gather this matter into masses containing a smaller percentage of water than before coagulation, and this coagulum, by reason of its buoyancy, carries some of the precipitants to the surface instead of being carried down by them. The experience at Lawrence has been similar to that at other places in the purification of such liquors by precipitation. At Bradford, Eng., the center of the English woolen trade, where it is calculated that 8 per cent. by volume of the sewage of the city comes from wool-washing establishments, it has been shown that from nine to twelve times as much precipitant is needed when treating week-day sewage as when treating Sunday sewage, free from this waste.

Straining through Coke and Cinders.

Experiments have shown that a considerable clarification can be obtained by passing these liquors to beds of coke or cinders; in fact, if the liquor is to be considered a sewage, and passed into the sewers of a town or city, the most successful method of treatment is undoubtedly by the combination of settling tanks and coke strainers, the mixture of the clarified effluent with the domestic sewage being passed to an ordinary filter bed.

At a fourth factory the liquors came from the processes of scouring wool, washing yarn, cloth-washing and dyeing, and the total volume amounted to 30,500 gallons per day, divided as follows: 21,000 gallons from wool-scouring, 2,100 from yarn-washing, 400 from cloth-washing and 7,000 from dyeing.

Acid Treatment.

Many examinations and experiments were made at the station with these liquors, and it was estimated from the analyses that the organic matter in them was equal to that in 200,000 gallons of domestic sewage such as flowed to the area to which it was proposed to pass these wastes. It was found that only about 20 per cent. of the organic matter in suspension would settle out in twenty-four hours; that the use of 25,000 pounds of sulphuric acid per million gallons of liquor treated caused good coagulation of the fatty matters and left the organic matter in such a condition that it could be filtered or strained easily, leaving a clear

liquor. It was decided that if these wastes were passed through settling and acid treatment tanks they would then be sufficiently purified or freed from organic matters to pass the town sewers. The experiments showed that in this way about 70 per cent. of the organic matter and 90 per cent. of the fats present would be removed, and that by further treatment upon coke or sand strainers the removal of fatty matters would approximate 99 per cent. At many places abroad and at several places in this country — two in Massachusetts — this sludge is further treated in heated filter presses, to extract the grease. Grease extracted in this way in Massachusetts can be sold ordinarily for about 2 cents per pound.

New Processes.

Owing partly to the difficulty of treating this liquid like domestic sewage and partly to the fact that it contains a valuable amount of grease, ammonia and potash, many processes are being tried abroad in the hope that these various bodies can be saved. The old method of accomplishing partial recovery consists simply, as stated previously, in the application of sulphuric acid, by which the fats are to a certain extent coagulated and removed by settling tanks and strainers. A method of treatment said to be used abroad for the recovery of fats, soap, etc., is known as the Yaryan process. By this process the liquors from wool-scouring, cloth-washing, etc., after partial evaporation in a special form of evaporator, have the fats separated from the water by means of a centrifugal machine. The water after this separation is evaporated and the potassium carbonate recovered. The steam from this evaporation is sometimes condensed and the distilled water thus produced used for scouring, etc.

At one of the large mills at Lawrence, Mass., all the wool is now treated by a patented naphtha process, and it is stated that about 50,000 pounds of wool grease are saved each week. It is also stated by the mill authorities that the process is a profitable one, and that there is a ready sale for the grease produced. Of course, the naphtha treatment removes only fatty matters, etc., and a large amount of dirt still remains to be washed from the wool. Grease extracted from the wool by this naphtha process is said to command ordinarily a price about twice as great as that produced by acid treatment.

The following table shows the character of the strong waste wool-scouring liquor from several large woolen and worsted mills in Massachusetts. The figures given on the table are in each case the average of many analyses.

Average Analysis of Samples of Waste from Mill A.

[Parts per 100,000.]

Total Residue.		Loss on Ignition.		Free Ammonia.	Kjeldahl Nitrogen.		Oxygen Consumed.	Fats.
Total.	Dissolved.	Total.	Dissolved.		Total.	In Solution.		
9,554.2	4,038.2	7,331.0	2,446.0	10.94	132.6	65.5	574.7	5,135.0

Average Analysis of Samples of Waste from Mill B.

6,907.0	3,657.0	4,019.0	1,680.0	3.23	127.3	67.2	313.6	2,009.0

Average Analysis of Samples of Waste from Mill C.

21,790.3	4,759.3	7,861.3	2,401.3	15.73	229.9	86.9	938.3	4,150.0

Average Analysis of Samples of Waste from Mill D.

3,914.7	2,178.0	2,452.0	1,183.4	29.57	64.7	34.8	295.0	1,656.0

Woolen Mill Wastes.

The entire wastes from several woolen mills were studied at the station, with the following results: —

Mill No. 1.

The wastes from this mill consisted of water used in washing woolen cloth before dyeing, in dyeing the cloth and in washing the cloth after dyeing. The liquor from cloth-washing was the usual heavy, soapy liquid, rich in organic matter and containing much matter in suspension. The dyes used were generally of the aniline and black logwood varieties, the wastes being, therefore, generally black. In washing the cloth after dyeing, a solution of "black iron," consisting of muriatic acid, nitric acid, and copperas, was added to the water in which the cloth was washed. The total volume of waste water from this mill averaged from 150,000 to 200,000 gallons per day. The average waste varied in character according to the relative volumes of the different wastes coming from the mill, and was generally a black and very turbid liquid containing a large amount of matter in suspension. It did not putrefy, and much of the matter in suspension precipitated readily. Experiments with chemical precipitants showed that from 3,000 to 5,000 pounds of lime per million gallons of waste treated brought about good coagulation and precipitation, together with a removal of most of the coagulating matter. The use of 3,500 pounds of lime per million gallons of liquor caused the

removal of 80 per cent. of the nitrogen determined as albuminoid ammonia, over 90 per cent. of the matters determined by the oxygen consumed test, together with about 70 per cent. of the organic and other matters determined by loss on ignition. As the volume of waste from this mill was about 200,000 gallons daily, about 700 to 1,000 pounds of lime would be required if chemical precipitation of the waste was followed, this meaning an expense of about $2 daily for lime.

Two small filters were operated at the station: to one (No. 301) the average waste was added at a rate of 100,000 gallons per acre daily for two months. Then for two months it was operated at a rate of 55,000 gallons per acre daily with the supernatant liquor after chemical precipitation. The effluent from this filter was always clear, light green in color and non-putrescible. The second filter (No. 303) was operated for four months at a rate of 100,000 gallons per acre daily, and received the supernatant liquor after sedimentation without chemical treatment. This filter also gave a clear, non-putrescible effluent, of a quality fully as good as that receiving the waste after treatment with chemicals. Each filter was constructed of 3 feet in depth of sand of an effective size of 0.28 millimeter.

The average analyses of the raw waste, of the waste applied to and of the effluent from each filter, together with the percentage removal of organic matter, are shown in the following table: —

Filter No. 301.

WASTE.	Total Residue.	Total Loss on Ignition.	AMMONIA.		NITROGEN AS —		Oxygen Consumed.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Raw,	118.7	47.6	.1200	.8900	–	–	19.86
Applied,	166.4	13.1	.0747	.1340	–	–	2.90
Effluent,	121.8	8.7	.0516	.0950	.07	.0062	1.57
Percentage removal: —							
By precipitation,	–	72	38	85	–	–	85
By precipitation and filtration.	–	82	57	89	–	–	92
By filtration,	27	34	31	29	–	–	46

Filter No. 303.

WASTE.	Total Residue.	Total Loss on Ignition.	Free.	Albuminoid.	Nitrates.	Nitrites.	Oxygen Consumed.
Raw,	118.7	47.6	.1200	.8900	–	–	19.86
Applied,	123.9	28.5	.1013	.2960	–	–	11.90
Effluent,	105.3	10.4	.0211	.0751	.00	.0002	2.37
Percentage removal: —							
By precipitation,	–	40	16	67	–	–	40
By precipitation and filtration.	11	78	82	92	–	–	88
By filtration,	15	64	79	75	–	–	80

Mill No. 2.

The wastes from this mill were of four classes: (1) liquors from wool-scouring processes, (2) spent dye liquors, (3) wash water, (4) waste water from a shoddy mill. It was impossible to obtain an accurate estimate of the relative volumes of these wastes as the mill buildings covered a large area and were built over race-ways connecting the pond on one side of the mills with the river on the other side. The apparatus in the scouring department consisted of two sets of 4 tanks each, one set of 2 tanks and 6 large round kettles for carbonizing; in the dye-house there were 33 kettles for dyeing piece-cloth and 48 kettles for dyeing wool; in the washing department there were 40 washing machines, 7 of which were used in the neutralizing room; in the shoddy mill there were 3 beater-engines, similar to those used in paper mills, 2 shoddy scouring-tanks and 4 acid tanks. The volume of waste resulting from the apparatus used was about as follows: —

Process.	Gallons per Day.	
	Average.	Maximum.
1,	100,900	201,800
2,	1,569,400	2,186,400
3,	1,671,600	2,417,000
4,	36,400	100,500
Total,	3,378,300	4,905,700
Very Objectionable Wastes.		
1,	42,000	84,000
2,	161,600	242,400
3,	344,500	689,000
4,	8,900	17,900
Total,	557,000	1,033,300

Average samples of these wastes were sent to the experiment station in August, 1909. The samples as received were very highly colored, generally by a blue dye, and contained a large amount of organic and mineral matter in solution and in suspension. The average analyses of the waste before and after sedimentation follow: —

Raw Waste.

[Parts per 100,000.]

Unfiltered.			Filtered.			Ammonia.			Oxygen Consumed.
						Free.	Albuminoid.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.		Total.	In Solution.	
150.0	60.0	90.0	108.0	30.2	77.8	.58	.80	.30	8.14
Settled Waste.									
94.1	26.9	67.2	–	–	–	.48	.31	–	3.61

Two filters, Nos. 380 and 381, were put into operation, receiving the supernatant waste after sedimentation. No. 380 was a trickling filter constructed of 6 feet in depth of broken stone, and No. 381 was constructed of 3½ feet in depth of sand with an effective size of 0.26 millimeter. The trickling filter (No. 380) was operated for seven weeks at rates varying from 500,000 to 750,000 gallons per acre daily. Its effluent was found to differ little in appearance and analysis from the applied waste. Filter No. 381 was first operated at a rate of 50,000 gallons per acre daily; then, after a few weeks, at a rate of 150,000 gallons per acre daily with the effluent from Filter No. 384. (See below.) Operated in this way, Filter No. 381 gave an effluent which was always clear and odorless, but more or less colored by the blue dye in the applied waste. A large part of the organic matter applied was removed by the filter, as is shown by the following average analysis of its effluent: —

Average Analysis of Effluent from Filter No. 381.

[Parts per 100,000.]

Ammonia.		Nitrogen as —		Oxygen Consumed.
Free.	Albuminoid.	Nitrates.	Nitrites.	
.3839	.0703	.37	.0092	1.29

Filter No. 384 contained 2 feet in depth of sand and was operated at a rate of 1,500,000 gallons per acre daily. After three weeks' operation the upper sand in the filter became badly clogged; 3 inches of sand were removed and a few days later the rate was reduced to 1,000,000 gallons

per acre daily. Subsequently, when the surface sand became again badly clogged, the sand throughout the entire depth of the filter was examined, which examination showed that the clogging was confined practically to the upper 3 inches, and was due to fatty matters present in the wastes on account of the addition to these average wastes of those from wool-scouring. The fatty matters present in the upper 3 inches of sand averaged 500 parts per 100,000. The effluent from the filter was always clear and odorless, but had considerable color. The average analysis of its effluent for the two months of its operation was as follows: —

Average Analysis of Effluent from Filter No. 384.

[Parts per 100,000.]

Ammonia.		Nitrogen as —		Oxygen Consumed.
Free.	Albuminoid.	Nitrates.	Nitrites.	
.2347	.1614	.03	.0004	1.88

The experiments with the wastes from this mill indicated that they could be purified without any great difficulty to a degree sufficient to allow their entrance into the river without nuisance, by a sand filter, or strainer, operated at a rate of 500,000 gallons per acre daily, with the production of an effluent containing but a small percentage of the organic matter in the original waste. The waste before passing to such a filter should have passed through ample settling basins to allow time for the sedimentation of the large amount of matter in suspension, and the waste from the wool-scouring processes should have received separate treatment to remove the fatty matters before being mixed with the remaining wastes from the mill.

Mill No. 3.

The wastes discharged from this mill came from the processes of washing, boiling and dyeing heavy woolen cloth, the total volume of waste amounting to between 30,000 and 35,000 gallons daily. Aniline dyes were used. The process of washing after dyeing covered a period of from one and one-half hours to two hours. The first waste wash-water discharged was dirty and black, and contained large quantities of heavy suspended matter. During the rest of the washing period the water was much clearer, and contained but small amounts of matters in suspension. The total waste water from the mill consisted of approximately 1 part of spent dye liquor to 13 parts of the water from cloth-washing.

In 1906 two filters were put into operation at the station to receive this waste. Filter No. 307 contained 3 feet in depth of sand of an effective size of 0.28 millimeter, and was operated at a rate of 100,000 gallons per acre daily with the supernatant liquor after treatment with 5,000 pounds of lime and 5,000 pounds of copperas per million gallons. The effluent from the filter was always slightly turbid and of a light green color, but was non-putrescible. After a few weeks' operation the rate of this filter was reduced to 50,000 gallons per acre daily, with much better results. Average analyses of the waste before chemical treatment, of the waste after chemical treatment, and of the effluent from the filter follow.

To Filter No. 308, containing 4 feet in depth of sand of an effective size of 0.25 millimeter, the supernatant liquor after sedimentation only was applied, first at a rate of 100,000 gallons per acre daily and later at a rate of 50,000 gallons per acre daily. The effluent from this filter was always clearer than that of the filter receiving the treated waste, was less turbid, had less color, and was always non-putrescible.

The average analyses of the waste before sedimentation, after sedimentation and of the effluent from the filter follow.

Filter No. 307.

[Parts per 100,000.]

Waste.	Total Residue.	Total Loss on Ignition.	Ammonia.		Nitrogen as —		Oxygen Consumed.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Raw, ...	270.4	121.5	.3900	2.1900	-	-	18.13
Applied, . . .	234.8	66.9	.4233	0.6700	-	-	11.13
Effluent, . . .	176.8	21.8	.0354	0.1465	.10	.0028	1.93
Percentage removal, .	-	67.4	-	78.1	-	-	82.7

Filter No. 308.

Raw, ...	270.4	121.5	.3900	2.1900	-	-	18.13
Applied, . . .	264.5	111.1	.3867	0.9500	-	-	14.20
Effluent, . . .	147.6	17.5	.0128	0.0775	.00	.0001	1.50
Percentage removal, .	-	84.2	-	91.8	-	-	89.4

The experiments carried on at Lawrence indicated that the waste water could be satisfactorily treated by means of plain sedimentation followed by intermittent filtration through 3 or 4 feet of moderately fine sand, at a rate not exceeding 50,000 gallons per acre daily.

Mill No. 4.

The wastes from this mill came from the processes of washing and dyeing cloth and dyeing raw cotton. In cloth-washing the cloth is first saturated with soap in the fulling machines and then washed for a period of from twenty to thirty-five minutes. The total amount of wash-water from this process was between 30,000 and 40,000 gallons daily. From 12,000 to 15,000 gallons of this contained considerable soap, the remainder being practically clear. The dyes used were heavy logwood and aniline dyes, and the waste discharged consisted of the spent dye liquor together with the rinse water. The total volume of water from dyeing and rinsing amounted to about 21,000 gallons per day. The worst wastes discharged from the mill consisted of from 12,000 to 15,000 gallons of wash-water used in washing cloth and about 12,000 gallons of spent dye liquor per twenty-four hours.

On Oct. 22, 1906, a mixture of the worst wastes from the mill was applied after sedimentation to a filter (No. 320) containing 3 feet in depth of sand of an effective size of 0.25 millimeter, at a rate of 100,000 gallons per acre daily. This waste was very turbid, pinkish in color, non-putrescible, and deposited only a small amount of matter when allowed to stand. Eighty-five per cent. of the organic matter in the applied waste as shown by albuminoid ammonia determinations, and 89 per cent. as shown by the oxygen consumed results, were removed by the filter. The effluent was clear, colorless and non-putrescible.

The average analyses showing these results follow: —

Average Analysis of Waste Liquor, Filter Effluent and Percentage Removal of Organic Matter.

Filter No. 320.

Waste.	Total Residue.	Total Loss on Ignition.	Ammonia.		Nitrogen as —		Oxygen Consumed.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Raw,	162.3	62.4	.1000	.5830	-	-	11.40
Applied,	150.6	54.6	.0700	.3400	-	-	8.47
Effluent,	115.3	12.6	.0280	.0514	.01	.0023	0.97
Percentage removal: — By sedimentation,	7	12	30	42	-	-	22
By sedimentation and filtration.	29	80	72	91	-	-	91
By filtration,	23	77	60	85	-	-	89

The plans for the purification of these wastes showed two sand filter beds having a combined area of half an acre, these beds to be under-

drained by tile pipe 3½ feet below the surface of the sand. This area seemed to be ample for the treatment of the waste liquor from this mill. With a total volume of 30,000 gallons per day, the rate of filtration through these beds would be 60,000 gallons per acre daily, and although the amount of matter settling from these wastes was slight, some provision for sedimentation seemed desirable.

Carpet Mill Wastes.

During 1904, 1905 and 1906 investigations were carried on by the Board in regard to the wastes at the works of a carpet company. The principal wastes were from the processes of scouring wool, yarn, etc., and had the general appearance and character of such wastes; that is, they were heavy, soapy liquids, semi-emulsions of fat, dirt and soap, and containing a large amount of solid matter, sometimes 2,000 or 3,000 parts per 100,000 parts, or seventy to one hundred times as much as an ordinary Massachusetts domestic sewage. They contained, also, an amount of organic matter determined as albuminoid ammonia often ten to twenty times as great as that in average domestic sewage, and the organic matter, as shown by the determination of oxygen consumed, was correspondingly high.

Measurements made in 1904 of the amount of waste from the various machines at the mill follow: —

Source of Waste.	Gallons per Day.	Source of Waste.	Gallons per Day.
Strip washer,	3,850	Yarn washer No. 2,	1,047
Drum sheet tank,	353	Centrifugal washer,	3,000
Sheet washer tank,	270	Wool-dyeing machine,	2,950
Sheet washer (continuous flow),	14,600	Brussels yarn dye tubs, blue and black,	1,140
Hot washer and paste barrels,	150	Washing tank (continuous flow),	3,270
Wool-scouring machine,	1,700	Blue dye washing machine,	13,730
Brussels dye tubs,	7,460	Yarn dyers (three),	15,550
Yarn rinse box,	10,500	Wool-dyer machine (rinsing),	2,950
Yarn washer No. 1,	1,047		

Measurements made in 1908 showed the total volume to be much larger than that of 1904, but this increase was due largely to the use of clear water in the discharge pipes of the mill for the purpose of flushing. The actual volume of waste from the mill, not including this fairly clear water, was probably from 110,000 to 114,000 gallons per twenty-four hours.

In October, 1904, experiments were begun with the wastes from this plant. The waste dye liquors were densely colored, with green and red hues predominating, and were generally acid. Mixtures of the various wastes, made in proportions corresponding to the volume of each as it flowed from the mill, gave a liquor exceedingly rich in organic matter and of a green color. This mixed liquor was alkaline, owing to the large volume of wool-scouring liquor present, and this was the waste upon which the experiments upon sedimentation, chemical precipitation and filtration were made. It was found that by allowing the mixed or average waste liquor to stand for twenty-four hours there was removed by sedimentation about 50 per cent. of the total nitrogenous organic matter present and about 60 per cent. of the total organic matter. Ordinary coagulants, except in excessive and costly amounts, had comparatively little effect on the organic matter left after this sedimentation. Copperas and lime, when applied at the rate of 2,500 pounds of each per million gallons of liquor, reduced the nitrogenous matter left in the supernatant liquor after sedimentation about 23 per cent., and the total organic matter 35 per cent. The same precipitants, when used at the rate of 5,000 pounds per million gallons, reduced the nitrogenous matter 34.5 per cent., and the total organic matter remaining 50 per cent.

Seven filters, constructed of different filtering materials were started and kept in operation for five weeks, for the purpose of studying the most suitable and efficient method for the filtration of these wastes. Three of these were constructed of sand of an effective size of 0.33 millimeter, and were operated at rates varying from 100,000 to 500,000 gallons per acre daily. The other four filters were constructed of cinders, soft coal, coke breeze and charcoal, respectively, and each was operated at the rate of 500,000 gallons, with the exception of the cinder filter, which was operated at a rate of 1,000,000 gallons per acre daily with the supernatant liquor after twenty-four hours' sedimentation of the waste. These experiments showed that sand filtration at a comparatively low rate gave the best purification; that by chemical precipitation followed by sand filtration at a rate higher than that usual with filters receiving the supernatant liquor from simple sedimentation more organic matter could be removed, but not enough more to compensate for the chemicals used; that with a cinder filter operated at a 1,000,000-gallon rate purification nearly as good could be obtained as that with the low-rate sand filter, but that excessive clogging necessitated frequent removal of filtering material; that a coke breeze filter at a 500,000-gallon rate gave as good results as a cinder filter at a 1,000,000-gallon rate, and nearly as good results as the low-rate sand filter;

and that none of the filters removed much of the green color of the applied liquor.

In December, 1905, additional experiments were begun, and six filters were put into operation, receiving the supernatant liquor after sedimentation of the entire waste, one being constructed of cinders and the others of sand, and these filters were continued in operation for nearly seven months. A filter constructed of 18 inches in depth of cinders was operated at a rate of 500,000 gallons, and its effluent was applied to a filter constructed of 27 inches in depth of sand and operated at a rate of 100,000 gallons per acre daily. This combination of filters removed from the applied liquor 62 per cent. of the nitrogen determined as albuminoid ammonia, 62 per cent. of the organic nitrogen, 65 per cent. of the organic matter determined as oxygen consumed, 23 per cent. of the total solids, and 56 per cent. of the combustible solids.

A second combination, consisting of three sand filters of equal areas and each constructed of 3½ feet in depth of sand, was put into operation at the same time, the supernatant liquor after sedimentation being applied to the first of these sand filters at a rate of 100,000 gallons per acre daily, the effluent from the first filter to the second, and the effluent from the second to the third. As a result of this experiment the percentage removal of the organic matters, etc., in the applied liquors was as follows: —

Per Cent. Removed.

Filter No.	Ammonia.		Kjeldahl Nitrogen.	Oxygen Consumed.	Solids.		
	Free.	Albuminoid.			Total.	Loss.	Fixed.
293, ...	53	56	66	65	24	53	7
293 and 294, . .	77	71	77	76	40	72	22
293, 294 and 295, .	78	81	86	84	51	79	33

During the same period a filter of the same depth of sand, Filter No. 296, was operated at one-third the rate of each of the three filters just described, namely, 33,300 gallons per acre daily, this rate giving the same rate per unit of surface as the combination just described. The percentage removal of matter present in the applied liquor was as follows, and was practically the same as that of the three filters operated at higher rates: —

Filter No. 296. — Per Cent. Removed.

Ammonia.		Kjeldahl Nitrogen.	Oxygen Consumed.	Solids.		
Free.	Albuminoid.			Total.	Loss.	Fixed.
76	78	84	82	46	72	30

The effluents from all these filters, with the exception of the shallow cinder filter, were clear and generally green in color. They were perfectly stable, no putrefaction ensuing when kept in the warm laboratory for weeks, although the waste itself quickly putrefied. The work done by all these filters improved steadily, nitrification taking place in each of them during the last two months of operation.

The results of the work carried on with these wastes during the period described appeared to prove that an effluent of good quality could be obtained by the use of settling tanks holding one day's flow from the mill, this to be followed by sand filtration of the supernatant liquor at a rate as high as 50,000 gallons per acre daily, the sedimentation removing about 50 per cent. of the total organic matter present and filtration removing about 75 per cent. of that remaining.

Average Analyses. — Untreated Waste Liquor.

[Parts per 100,000.]

Residue.		Loss on Ignition.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Oxygen Consumed.
				Free.	Albuminoid.				
Total.	Dissolved.	Total.	Dissolved.		Total.	Dissolved.			
425.6	331.0	230.1	141.8	1.66	2.52	0.85	4.87	5.06	49.37

Filter No. 284. — Applied Waste Liquor. (Supernatant after Twenty-four Hours' Sedimentation.)

[Parts per 100,000.]

Solids.			Ammonia.		Kjeldahl Nitrogen.	Nitrates.	Oxygen Consumed.
Total.	Loss.	Fixed.	Free.	Albuminoid.			
200.7	89.7	111.0	.6243	.8488	1.9517	-	12.56

Filter No. 284.[1] *— Effluent.*

[Parts per 100,000.]

Solids.			Ammonia.		Kjeldahl Nitrogen.	Nitrates.	Oxygen Consumed.
Total.	Loss.	Fixed.	Free.	Albuminoid.			
147.1	42.9	104.2	.4525	.4789	1.1195	.05	8.24

Filter No. 285.[2] *— Effluent.*

129.9	18.2	111.7	.2145	.2187	0.6452	.17	3.64

Filter No. 293.[3] *— Effluent.*

137.6	21.3	116.3	.5275	.2455	0.4338	.05	3.82

Filter No. 294.[4] *— Effluent.*

118.3	12.4	105.9	.0911	.1568	0.2911	.32	2.35

Filter No. 295.[5] *— Effluent.*

101.2	10.4	90.8	.0679	.1126	0.1853	.38	1.77

Filter No. 296.[6] *— Effluent.*

112.7	14.1	98.6	.1189	.1312	0.2036	.30	2.17

[1] Filter No. 284, started Dec. 15, 1905. Contained 18 inches in depth of cinders passing a 4-inch mesh and held back by a 6-inch mesh. Rate, 500,000 gallons per acre daily. January 26 rate was decreased to 250,000 gallons per acre daily.

[2] Filter No. 285 contained 27 inches in depth of sand of an effective size of 0.28 millimeter. Started Dec. 15, 1905. Operated at a rate of 100,000 gallons per acre daily, receiving the effluent from Filter No. 284.

[3] Filter No. 293 contained 3½ feet in depth of sand of an effective size of 0.28 millimeter. Started Jan. 29, 1906. Operated at a rate of 100,000 gallons per acre daily with supernatant liquor after twenty-four hours' sedimentation.

[4] Filter No. 294 was a duplicate in construction of Filter No. 293. Operated at a rate of 100,000 gallons per acre daily with the effluent from Filter No. 293.

[5] Filter No. 295 was a duplicate in construction of Filter No. 293. Operated at a rate of 100,000 gallons per acre daily with the effluent from Filter No. 294.

[6] Filter No. 296 was a duplicate in construction of Filter No. 293. Operated at a rate of 33,000 gallons per acre daily, receiving supernatant waste after sedimentation.

Waste Liquors from Paper Mills.

The waste liquors from paper mills can be divided into two groups, the first including the waste liquors from washing and preparing the stock, and the second including waste liquors produced in working this stock up into paper. The volume of the liquors from washing and preparing the stock is much smaller than that used in the process of manufacture, but it contains a much larger percentage of organic matter. The total volume of waste liquors discharged from a paper mill is generally very large. This volume in 1895 from two plants, taken as good examples of the paper-making industry in Massachusetts, varied in both cases between 2,000,000 and 3,000,000 gallons per day. In one plant there was worked up yearly about 5,100 tons of a stock consisting largely of old paper, but including a considerable amount of old rope and bagging, and also a small amount of old oilcloth. In making this stock into paper about 1,000 tons of chemicals and dyestuffs were used yearly, consisting of alum, quicklime, chloride of lime or bleach, soda ash, copperas, china clay, caustic soda, starch, aniline dyes, bichromate of lead, etc. The second mill investigated as to the volume of its waste liquor produced about 4,000 tons of paper yearly, and used also a very large amount of chemicals, dyestuffs, etc. The waste liquors produced by boiling rags in caustic soda, caustic lime, or mixtures of soda ash and lime, in order to free them from grease, dirt and coloring matter, are of such composition that it is practically impossible to purify them by intermittent filtration. A sand filter operated at the station in 1895, to which such a liquor was applied, gave very poor results, and other experiments made since that date with like liquors have resulted similarly.

The following table gives the average analysis of the liquor applied to and of the effluent from the filter mentioned, — Filter No. 60, $\frac{1}{20000}$ of an acre in area and containing 5 feet in depth of sand of an effective size of 0.25 millimeter. It was operated at the rate of 65,000 gallons per acre daily.

Average Analysis of Liquor Applied to Filter No. 60.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
Free.	Albuminoid.		Nitrates.	Nitrites.		
2.30	5.10	20.00	.0000	.0000	140.00	–

Average Analysis of Effluent from Filter No. 60.

1.09	2.29	12.59	.1050	.0067	84.36	3,092,000

Continued experimentation made it clear that the only satisfactory method of treatment of the strong alkaline liquor alone was by evaporation and by recovery of chemicals, and this method is used in many places at home and abroad.

An average analysis made in 1895 of the mixed waste liquors from each of the mills mentioned above resulted as follows: —

Mill No. 1.

[Parts per 100,000.]

Solids.		Ammonia.		Chlorine.	Oxygen Consumed.
Total.	Loss on Ignition.	Free.	Albuminoid.		
43.00	20.00	.0200	.1500	1.00	3.00

Mill No. 2.

51.00	31.00	.0150	.1500	1.50	4.00

Experiments made in 1895 and 1896 showed that either or both of these liquors could be passed through sand filters at rates of from 200,000 to 400,000 gallons per acre daily, with a clear, bright and well-purified effluent as a result. Little nitrification occurred in the sand filters receiving such liquor, and the fibrous matter in it, of which the chief organic pollution was composed, formed a mat over the surface of the filter often tenacious enough to hold together and to be easily rolled up and removed. The average analysis of the effluent from a sand filter, containing 4.5 feet in depth of sand of an effective size of 0.23 millimeter, which received the mixed liquors of the composition shown above and at the rates mentioned, was as follows: —

Effluent from Filter No. 77.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.
Free.	Albuminoid.		Nitrates.	Nitrites.	
.0086	.0219	1.31	.0096	.0024	.34

Straining through Coke.

In order to test the value of coke as a strainer in removing the impurities from these paper mill liquors, a small coke strainer, $\frac{1}{20000}$ of an acre in area, was kept in operation at one of the mills for a period of

several months. To this strainer liquors from all the processes of washing and manufacture of paper at the mill were applied, and the rate of operation varied from 500,000 to 2,000,000 gallons per acre daily. It gave a uniformly clear, practically colorless effluent, and there was deposited upon its surface a large accumulation of dirt, fibrous matter, etc., which was rolled up from time to time and removed. A cinder strainer was equally efficient.

A small coke strainer to which these liquors were applied was kept also in operation at the station for a period of several months, at the rate of 1,000,000 gallons per acre daily. The effluent of the strainer was clear, almost colorless and contained little organic matter. The average analysis during its period of operation, when receiving the mixed liquor, was as follows: —

Effluent from Coke Strainer No. 77A.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.
Free.	Albuminoid.		Nitrates.	Nitrites.	
.0161	.0311	2.10	.0064	.0019	.87

Screening, Sedimentation and Chemical Precipitation.

Much of the organic pollution in the mixed liquors is in suspension, and is quite readily removed by passing the liquors through fine wire screens. In some mills a considerable portion of fine pulp which passes through the paper machines is saved in this way, and it is evident that a large part of the dirt in the various wash waters can be screened out in the same way. Results obtained by sedimentation showed that about 30 per cent. of the total organic pollution could be removed from the waste liquors if they were allowed to settle for one hour, but that considerably longer periods of sedimentation failed to give much better reresults. With precipitants such as ferrous or aluminum sulphate, in the proportion of 500 pounds per 1,000,000 gallons of liquor treated, about 45 per cent. of the organic matters was removed.

Further Experiments with Wastes from Paper Mills.

Ten years later, in 1905 and 1906, the waste liquors from the two paper mills previously mentioned were again experimented with, and also the liquors from a third paper mill, with the following results: —

Paper Mill A.

The stock employed at this mill was made up of old manilla and jute rope and old bagging in proportions varying with the quality of paper produced, but averaging 52,000 pounds of rope and 6,000 pounds of bagging during each twenty-four hours. The stock is cut very fine and dusted, thereby losing much of its dirt. It is then boiled about nine hours in a rotary boiler under forty-five pounds' steam pressure, in the presence of large but varying amounts of lime and soda. Every morning these boilers are blown off, the stock is dumped and allowed to drain. In its pulpy condition the stock is then put into washing machines and washed three to four hours. It is bleached at the end of the wash, if necessary, by pickling in washing machines with bleaching liquor, and is then transferred to draining chambers. Some of the stock is used directly for paper after being beaten and ground, while some receives a second wash, and, after being beaten and ground, is run up on a paper machine.

The materials used in this mill averaged at the time of these experiments about as follows per twenty-four hours: —

52,000 pounds of old manilla and jute rope.
6,000 pounds of old bagging.
5,400 pounds of lime.
600 pounds of soda ash.
1,400 pounds of bleaching powder.
1,500 pounds of white clay.
250 gallons of sizing solution, dyes, etc.

The volumes of waste liquors from the mill per day were about as follows: —

30,000 gallons of boiler waste.
900,000 gallons of water used in washing the stock from the boilers.
75,000 gallons from draining chambers.
200,000 gallons from the stock washed a second time.
500,000 gallons from paper machines.
150,000 gallons from cleaning the mechanical filters.

The waste liquors were divided into three classes: boiler wastes, washing-machine wastes and paper-machine wastes. Two large settling tanks and a number of experimental filters were constructed and put into operation at this mill in July, 1905, and the experiments were continued until November, 1906. Until Dec. 15, 1905, the liquor experimented with was made up of the boiler and machine wastes mixed in

proper proportions. The two settling tanks put into operation, namely A and B, were each 9 feet in diameter at the bottom, 8 feet at the top and 8¾ feet deep; and the capacity of each was approximately 3,400 gallons. Each tank had three vertical partitions about 1½ feet apart, stretching across the tank and extending downward from the surface of the water about 3 feet, in order to break the current between the inlet and outlet pipes. The outlet of each tank was a siphon arranged to draw the waste a short distance below the surface. During the first period of operation of these tanks they received mixed rotary wastes and washing-machine wastes, with the result that little sedimentation occurred. During a period of five months in 1906, however, the tanks received the waste liquor from the washing machines only, and during this time they removed 39 per cent. of the organic matter determined as loss on ignition and 32 per cent. determined as albuminoid ammonia. The analyses of the liquor entering and of the effluent from these tanks during this latter period follow: —

Tanks treating Paper Mill Waste.— Average Analyses and Percentage Removal for the Months of June to October, inclusive.

Tank A.

	Residue.		Loss on Ignition.		Ammonia.				Oxygen Consumed.	
						Albuminoid.				
	Total.	Dissolved.	Total.	Dissolved.	Free.	Total.	Dissolved.	Suspended.	Unfiltered.	Filtered.
Applied water,	162.65	80.91	81.28	37.98	.0553[1]	.4355	.2675	.1680	31.87	17.06
Effluent,	95.41	58.33	49.63	30.06	.0292[1]	.2959	.1963	.0997	19.89	12.53
Percentage removal,	41.3	27.9	38.9	20.8	47.2[1]	32.1	26.6	40.7	37.6	26.5

Tank B. [2]

Applied water,	144.43	69.77	74.33	32.95	.0299[3]	.2930	.1829	.1095	29.75	14.05
Effluent,	84.26	54.97	44.72	28.53	.0104[3]	.2433	.1697	.0725	29.08	19.37
Percentage removal,	41.7	21.2	39.8	13.4	63.2[3]	17.0	7.2	33.8	2.3	—37.9

[1] July 1 to October 31. [2] June to September 30. [3] July 1 to September 30.

Filters Nos. 1 and 2.— Two filters, each 1/217 of an acre in area, were put into operation in July, 1905, and were operated until November, 1906. Filter No. 1 was constructed of 20 inches in depth of cinders and

Filter No. 2 of from 25 to 30 inches in depth of sand of an effective size of 0.20 millimeter. Each filter received, until December, 1905, the mixture of boiler and washing-machine waste coming from the settling tanks. After that date each filter received the waste liquor from the washing machines after this waste had passed through the settling tanks. Each filter was operated intermittently at rates varying from 200,000 to 1,000,000 gallons per acre daily, but it became evident that the maximum rate at which they could be operated with good results was from 200,000 to 300,000 gallons per acre daily. Filter No. 1 removed during its period of operation 54 per cent. of the applied organic matter as shown by the loss on ignition determinations and 55 per cent. of the nitrogenous matters as shown by determinations of albuminoid ammonia. Filter No. 2 removed 59 and 60 per cent., respectively, of the organic matter as shown by similar determinations. Each filter when operated at a reasonable rate produced a non-putrescible effluent. Each filter required raking several times during its period of operation, and from Filter No. 2, 3 inches in depth of sand were removed on Oct. 27, 1905.

The average analysis of the effluent from each of these two filters follows: —

Effluent from Filter No. 1.

[Parts per 100,000.]

Total Residue.	Total Loss on Ignition.	Ammonia.		Oxygen Consumed (Unfiltered).
		Free.	Albuminoid.	
76.23	27.52	.0869	.1520	8.44

Effluent from Filter No. 2.

69.23	24.23	.0725	.1373	7.65

Other filters also were operated at this time, some being constructed of sand and others of gravel. The gravel filters were operated as trickling filters at rates varying from 2,000,000 to 4,000,000 gallons per acre daily. Filter No. 1, as stated above, was $\frac{1}{217}$ of an acre in area and constructed of from 18 to 20 inches in depth of cinders with an effective size of 0.20; Filter No. 2 was $\frac{1}{217}$ of an acre in area, constructed of from 25 to 30 inches in depth of sand of an effective size of 0.20 millimeter; Filter No. 3 was $\frac{1}{875}$ of an acre in area and contained 30 inches in depth of fine sand of an effective size of 0.20 millimeter, underlaid with coarse gravel; Filter No. 4 was a trickling filter, $\frac{1}{20000}$ of an acre in area, and contained

5 feet in depth of gravel, all of which had a diameter less than 33 millimeters and none less than 6 millimeters, the effective size being about 10 millimeters; Filter No. 5 was a duplicate of No. 4; Filter No. 8 was 1/10000 of an acre in area and constructed of 20 inches in depth of fine sand of an effective size of 0.15 millimeter; Filter No. 10 was 1/272 of an acre in area and constructed of 6 feet in depth of small stones from 1/4-inch to 3 inches in diameter; and Filter No. 11 was 1/20000 of an acre in area and constructed of 8 feet in depth of coarse gravel similar to that in Filter No. 10.

The results obtained with most of these smaller filters, both sand and trickling, were of little value except in a negative way. The effluents from the trickling filters were generally putrescible, and those from the shallow sand filters, containing only a few inches in depth of sand, were little, if any, better. The best result was obtained from Filter No. 8. This filter was operated at a rate of 500,000 gallons per acre daily, and was dosed intermittently during nine hours of the day, being flooded every half-hour with the effluent from Filter No. 11, a filter operated as a trickling filter at a rate of 2,000,000 gallons per acre daily. The effluent from Filter No. 11 was always putrescible, but that from Filter No. 8 was clear and non-putrescible. Filter No. 11 was operated without difficulty for six months in 1906.

The average analyses of the applied waste and of the effluent, and figures showing the percentage of purification of each of these filters, follow: —

Average Analyses and Percentage Removal for the Months of June to October, inclusive.

Filter No. 1.

	Total Residue.	Total Loss on Ignition.	Ammonia.		Oxygen Consumed. (Unfiltered).
			Free.[1]	Albuminoid.	
Applied water,	95.41	49.63	.0292	.3578	19.89
Effluent,	46.84	16.56	.0080	.0909	4.01
Percentage removal,	50.9	66.6	72.6	71.8	79.8

Filter No. 2.

Applied water,	95.41	49.63	.0292	.3578	19.89
Effluent,	45.04	15.71	.0053	.0705	3.21
Percentage removal,	52.8	68.3	81.8	80.3	3.21

[1] July to October.

Average Analyses and Percentage Removal for the Months of June to October, inclusive — Concluded.

Filters Nos. 5 and 4.

	Total Residue.	Total Loss on Ignition.	Ammonia.		Oxygen Consumed (Unfiltered).
			Free.[1]	Albuminoid.	
Applied water,	91.88	47.23	.0292	.2811	19.17
Effluent,	49.38	20.27	.0106	.1401	7.91
Percentage removal,	46.3	57.1	63.7	50.2	58.7

Filter No. 5.

Applied water,	91.88	47.23	.0292	.2811	19.17
Effluent,	67.39	33.61	.0181	.1997	14.02
Percentage removal,	26.7	28.8	38.0	29.0	26.9

Filter No. 4.

Applied water,	67.39	33.61	.0181	.1997	14.02
Effluent,	49.38	20.27	.0106	.1401	7.91
Percentage removal,	26.7	39.7	41.4	29.8	43.6

Filter No. 10.

Applied water,	86.93	47.49	.0218	.2624	27.99
Effluent,	64.17	32.09	.0138	.1926	12.67
Percentage removal,	26.2	32.4	36.7	26.6	54.7

Filter No. 11.

Applied water,	86.93	47.49	.0218	.2624	27.99
Effluent,	57.83	27.42	.0147	.1822	11.96
Percentage removal,	33.5	42.3	32.6	30.6	57.3

Filter No. 8.

Applied water,	57.83	27.42	.0147	.1822	11.96
Effluent,	39.97	14.65	.0069	.0673	2.89
Percentage removal,	30.9	46.6	53.1	63.1	75.8

[1] July to October.

Paper Mill B.

This mill made approximately 25 tons of white magazine paper during every twenty-four hours. At the time of the experiments the stock used consisted of prepared wood pulp and rags, the amount of rags varying from 5 to 15 per cent. of the total stock used. But one rotary boiler was used at the mill, and this was emptied but three or four times a week, making the daily volume of boiler waste about 1,500 gallons. Lime only was used in the boiler, the amount being about 1,200 pounds at each charge. Considerable bleaching powder was used at the mill, also large amounts of china clay and size, as the product was a high-grade white paper. The total volume of waste water from the washing machines was about 400,000 gallons per day; that from the paper machines was much larger, but was almost all reclaimed, so that its treatment did not require attention.

An experimental plant was put into operation in December, 1905, consisting of one settling tank and one filter. The first experiments were made upon filtration of both boiler and washing-machine wastes, but they were unsuccessful. After May 17 the waste water experimented with was that from the washing machines only.

The settling tank was 5½ feet in diameter and 5 feet deep, holding 900 gallons, and was similar to Tanks A and B at the experimental plant of Paper Mill A. The tank was so operated that the time of passage of the waste liquor was approximately five hours during the period from December, 1905, to September, 1906. The rate of flow was then so increased that the waste took only two and one-half hours to pass through the tank. Analyses showed that this tank removed 79 per cent. of the total solid matter; 75 per cent. of the organic matter, as shown by loss on ignition; 75 per cent. of the nitrogenous organic matters, determined as albuminoid ammonia, and 78 per cent. of the organic matters determined by the oxygen consumed test. The tank was cleaned May 17, July 7, September 13 and October 9. The filter used was 11 feet in diameter, or $\frac{1}{450}$ of an acre in area, and was constructed of 24 inches in depth of screened cinders with an effective size of 0.20 millimeter. It received the effluent from the settling tank from December, 1905, to September, 1906, at a rate of 900,000 gallons per acre daily. The rate was then increased to 1,500,000 gallons per acre daily. The filter was raked three times during its period of operation and the material was scraped from it but once. This filter received the washing-machine waste, was very efficient and gave an effluent that was clear, practically colorless, odorless and non-putrescible.

The average analyses of the applied waste and of the effluents from both the settling tank and filter follow: —

Average Analysis of Waste Liquor applied to Settling Tanks.

[Parts per 100,000.]

Residue.		Loss on Ignition.		Ammonia.				Oxygen Consumed.	
				Free.	Albuminoid.				
Total.	Dissolved.	Total.	Dissolved.		Total.	Dissolved.	Suspended.	Unfiltered.	Filtered.
200.53	104.86	58.93	31.27	.2313	.4187	1.1950	.2237	20.30	12.29
Average Analysis of Effluent from Settling Tank.									
41.17	29.73	14.59	10.42	.0857	0.3533	0.4884	.0557	4.36	3.31
Average Analysis of Waste Liquor applied to Filter.									
40.79	–	15.01	–	.0755	0.3157	–	–	4.15	–
Average Analysis of Effluent from Filter.									
26.18	–	9.27	–	.0580	0.1312	–	–	1.94	–

Conclusions.

The experiments and investigations of the Board concerning the treatment of waste liquors from paper mills have shown quite clearly that a satisfactory method of treatment is to allow all the wastes, except perhaps those from the rotary boilers, to run together, and then to pass the liquor through coke or similar strainers at a high rate. The resulting effluent will be quite uniformly of good quality, and the wastes left upon the strainers will contain so much fiber as to be held together like matting and easily removed. At filter plants where mechanical filters and coagulants are used for clarifying the water supply use can be made of the wash water of these filters, inasmuch as they contain more or less chemicals, for partial purification of some of the wastes.

Waste Dye Liquors.

Early in the history of the station the purification of sewage colored with dyestuffs was given considerable attention, and it was found that a large proportion of the coloring matters in the sewages treated was

removed by intermittent sand filtration. Long-continued application of colored sewage to a filter, however, lessened its efficiency for removing these colors. In the review of the work upon the purification of tannery wastes it has been mentioned already that intermittent sand filters receiving these wastes, though highly colored oftentimes with dyestuffs, removed practically all of this color.

During 1903 much was done upon methods for decolorizing the dyehouse wastes from one of the large Lawrence mills. At this mill about 62,000 gallons of water were used each day in dyeing. The total volume of water used for dyeing and washing, however, averaged about 850,000 gallons per day. Cooling the water, for example, in the dye vats before discharging by adding large volumes of cold water, etc., caused a volume of colored water much larger than the 62,000 gallons actually used in the dye vats to be discharged from the mill. The dyes used varied greatly, but it is probable that anilines and a small amount of wood extracts were the colors contributing most largely to the wastes studied. The liquors were all so highly colored that a half-gallon bottle filled with them would scarcely allow the passage of light. There were all colors, from red to violet, but the predominating hue was blue-black. There was present, furthermore, considerable waste matter in suspension, consisting largely of pieces of yarn, etc.

Filtration of Dye Liquors.

Three filters — intermittent sand, coke contact and trickling — were operated with this waste. Each filter was 5 feet in depth, and the rates were 50,000, 400,000 and 540,000 gallons per acre daily, respectively. These filters were numbered 197, 198 and 199.[1] The sand filter, No. 197, was operated for seven months, produced a clear effluent having a pale yellow color and removed 95 per cent. of the organic matter. Contact Filter No. 198, operated for three months, removed the color less completely, but removed 80 per cent. of the organic matter. The trickling filter of broken stone, operated for three months, reduced the color even less than the contact filter, and removed about 70 per cent. of the organic matter of the wastes applied.

The average analyses of dye liquor and effluents are given in the following table: —

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[1] See pages 271–277, inclusive, report for 1903.

Average Analyses of Dye Liquor and Effluents.

[Parts per 100,000.]

	Appearance.		Ammonia.			Chlorine.	Nitrates.	Oxygen Consumed.
	Sediment.	Odor.	Free.	Total.	In Solution.			
Dye liquor, . . .	Decided.	Strong dextrine.	.3285	.2616	.1548	2.68	.00	6.28
Effluent from Filter No. 197,	None.	None.	.0219	.0193	–	–	.29	0.41
Effluent from Filter No. 198,	V. slight.	V. Slight.	.2413	.0672	–	1.89	.04	1.14
Effluent from Filter No. 199,	V. slight.	Slight.	.2608	.1034	–	1.59	.09	1.94

Chemical Precipitation of Dye Liquors.

Many experiments upon the treatment of these wastes by chemical precipitation were made. The wastes treated were all deeply colored red, blue, green, black, etc. With most of them the best results were obtained by adding lime and ferric chloride in varying proportions, the total amount added never being greater than one ton per million gallons treated. By this treatment practically all the coloring matters were often coagulated and removed. Other precipitants, such as copperas, iron, alum, etc., gave at times good results, either singly or in combination with each other or with lime. The amount of precipitant required varied greatly, according to the character of the dye liquors treated, but generally copperas followed by lime in amounts of about one-half a ton each per million gallons of dye liquor caused excellent coagulation and marked removal of color and organic matter.

Filtration of Clear Liquor from Chemical Treatment of Dye Wastes.

Filter No. 205. — This filter contained 4 feet in depth of sand with an effective size of 0.27 millimeter, over the usual underdrains. The filter received supernatant dye liquor from chemical treatment at the rate of 2,000,000 gallons per acre daily. It was operated for six months, and the average analysis of its effluent was as follows: —

[Parts per 100,000.]

Color.	Ammonia.		Nitrates.	Oxygen Consumed.
	Free.	Albuminoid.		
Pale yellow, ...	.3733	.0931	.12	1.54

Filter No. 214. — This filter was constructed of 4 feet in depth of soft coal ashes. It received supernatant dye liquor from chemical treatment at a rate of 2,000,000 gallons per acre daily. Its average analysis was as follows: —

[Parts per 100,000.]

Color.	Ammonia.		Nitrates.	Oxygen Consumed.
	Free.	Albuminoid.		
Light yellow, ...	.5000	.1047	.03	1.35

Treatment of Sludge on Ashes.

Filter No. 206. — This filter was constructed of 2 feet in depth of soft coal ashes. It received the sludge from chemical treatment of the dye liquor at a rate of 40,000 gallons per acre daily. The applied liquor generally disappeared in twenty-four hours, so that the filter was ready to receive the next day's application. When the period required for disappearance became unduly great, it was necessary to remove the sludge, and this was done four times in five months. The effluent from the filter was always clear and colorless, and it contained an exceptionally small amount of the organic matter, as the following average analysis shows: —

Average Analysis of Effluent from Filter No. 206.

[Parts per 100,000.]

Turbidity.	Color.	Ammonia.		Nitrogen as —		Oxygen Consumed.
		Free.	Albuminoid.	Nitrates.	Nitrites.	
None.	.05	.0352	.0104	.17	.0001	.10

Table showing Average Percentage Removal of Organic Matter from Dye Liquor by Various Treatments.

	Per Cent. Removed.	
	Albuminoid Ammonia.	Oxygen Consumed.
Chemical treatment: —		
Two hours' sedimentation, ...	21.3	55.9
Sixteen hours' sedimentation, ...	46.0	64.0
Effluent from Filter No. 205, ...	78.0	88.0
Effluent from Filter No. 197, ...	94.0	96.0

Waste Liquors from Creameries.

Experiments were made during 1898–99 upon methods for purifying the waste from creameries. This waste consisted largely of the water used in washing out cans, churns and other utensils, together with the milk washed from these cans. There was, of course, a very large amount of putrescible organic matter in this waste. A sample from a creamery, supposed to represent the strongest waste liquor from that place, was collected and analyzed, with the following results: —

Creamery Waste.

[Parts per 100,000.]

Solids.			Ammonia.				Oxygen Consumed.
			Free.	Albuminoid.			
Total.	Loss on Ignition.	Fixed.		Total.	In Solution.	In Suspension.	
145.0	130.7	14.3	.2120	4.62	0.72	3.90	51.20

Owing to the difficulty in obtaining samples representing the entire wastes from the creamery, it was thought that experiments with mixtures of milk and water in different proportions could be made at the experiment station, and that the results could be applied in the purification of the wastes from the creamery. The first experiment was as follows: —

A filter containing 4 feet in depth of clean sand of an effective size of 0.23 millimeter was put into operation on April 11, 1898, and received a mixture containing at first equal proportions of skimmed milk and water at the rate of 200,000 gallons per acre daily. The strength of this mixture was so great that it was applied to the filter for two days only. On the third day the rate was reduced to 100,000 gallons per acre daily, and the liquor applied contained one-third skimmed milk to two-thirds water. Even this mixture clogged the filter badly, and on April 22, 2 inches of curd were removed from its surface and the filter was dug over to a depth of 6 inches. After this the liquor applied to the filter contained only one thirty-fifth as much milk as water, and its analysis was as follows: —

Applied Liquor.

[Parts per 100,000.]

Ammonia.		Oxygen Consumed.	Bacteria per Cubic Centimeter.
Free.	Albuminoid.		
1.65	7.67	42.50	16,000,000

The amount of ammonia found in the mixtures of milk and water and also the amount of oxygen consumed from permanganate, varied with different samples of milk and with the same sample at different ages. The skimmed milk used at first was generally sour when applied to the filter, and the reaction of both the liquor applied and of the effluent was acid. No nitrification took place in the filter during this period, and the average analysis of the effluent for each of the two following months was as follows: —

Effluent.

[Parts per 100,000.]

Month.	Ammonia.		Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.	Nitrates.	Nitrites.		
1898.						
April, ...	5.20	18.50	.00	.0080	217.00	23,000,000
May, ...	15.23	2.72	.00	.0040	5.33	36,000,000

Beginning June 1 the mixture of milk and water was sweet at the time of application at least half the time, and, when sour, milk of lime was added in amounts varying from 1 to 13 grains per gallon, to make the liquor slightly alkaline. The effluent from the filter did not improve, however, and continued to have a strong odor of sour milk and an acid reaction. After this for two weeks the filter was flooded with water daily, the rate being the same as that with the mixture of milk and water. At the end of this period the filter was again in good condition and the liquor was applied once more. The effluent improved slightly from this time on, and nitrification was at times active. This activity continued for a large part of the next two months, but at times the results were still poor. The strength of the applied liquor was, therefore, still further reduced, so as to contain less than 1 per cent. of milk, whereupon good nitrification began again in the filter.

The effluent from the filter during the first months of operation had the odor of sour milk, and this odor persisted until the end of October. As

nitrification became fairly constant in the filter, the odor of the effluent became much less marked, and with the advent of colder weather it was distinctly less noticeable; and during 1899 the effluent was clear, practically colorless and without a distinguishing odor.

At the end of 1898 the rate of operation of the filter was reduced to 50,000 gallons per acre daily. The average analysis of the liquor applied to and of the effluent from the filter during the last three weeks of December, 1898, and the first week of January, 1899, was as follows: —

[Parts per 100,000.]

	Ammonia.		Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.	Nitrates.	Nitrites.		
Applied liquor,	.10	2.2500	–	–	9.15	–
Effluent,	.80	0.0750	2.70	.0500	0.38	77,000

On Jan. 7, 1899, the strength of the applied liquor was practically doubled, but the rate of application was reduced to 25,000 gallons per acre daily. The average analysis of the applied liquor during this period was about the same as that of the sample obtained from the creamery previously mentioned. The filter (No. 106) was continued in operation up to the end of November, 1899. Beginning in June, water at the boiling point was mixed with the milk, and it was still at about 100° F. when applied to the filter. This method was pursued because, at the creameries, the cans, churns, etc., were washed with boiling water. It was desired to ascertain not only what effect this treatment of the milk as washed from the utensils would have upon its purification by the bacteria in the filter, but also the effect of high temperatures upon the surface of the filter. Upon July 10 salt was added to the creamery waste applied to the filter thereby increasing the chlorine present to over 500 parts. This was done because considerable ice cream was made at the creamery during the summer months, and, consequently, the waste contained a large amount of salt. Nitrification within the filter was not seriously disturbed by any of these changes, however, although the amount of free and albuminoid ammonia in the effluent increased slightly. The filter continued to purify the waste successfully, as is shown by the following table, which gives the average analysis of the liquor applied to and of the effluent from the filter during the latter part of 1899: —

Creamery Wastes applied to Filter No. 106.

[Parts per 100,000.]

Quantity Applied. — Gallons per Acre Daily.	Temperature (Degrees F.).	Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Free.	Albuminoid.		Nitrates.	Nitrites.		
26,400	54	.2764	4.9800	208.00	-	-	35.82	-
Effluent from Filter No. 106.								
-	61	.5665	0.0969	214.85	6.61	.1594	0.68	46,400

The experiments with creamery wastes are described in the report of the Board for 1898, pp. 466–472, inclusive; and in the report for 1899, pp. 466–468, inclusive.

Binder's Board Wastes.

A filter (No. 310) was put into operation at Lawrence to which was applied the waste water from a mill making binder's board from old paper and clay. The waste was very foul, contained much heavy suspended matter and the daily volume discharged from the plant was from 250,000 to 300,000 gallons. The waste was generally colored brown, and the suspended matter settled readily. The supernatant waste after sedimentation was applied at the rate of 200,000 gallons per acre daily to a filter containing 4 feet in depth of sand of an effective size of 0.25 millimeter. The waste putrefied quickly, but the effluent from the filter was non-putrescible, fairly clear and practically odorless. Average analyses of the entire waste, of the supernatant liquor applied to and of the effluent from the filter follow. These analyses show that the filter removed 50, 82 and 81 per cent. of the organic matter in the applied waste, as shown by loss on ignition, albuminoid ammonia and oxygen consumed determinations, respectively.

Filter No. 310.

Waste.	Total Residue.	Loss on Ignition.	Ammonia.		Nitrogen as —		Oxygen Consumed.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Raw,	67.9	29.4	.1800	.3550	-	-	7.20
Applied,	32.1	16.0	.1197	.1930	-	-	3.72
Effluent,	24.9	7.9	.0102	.0355	.11	.0002	0.70
Percentage removal: —							
By sedimentation,	53	46	33	46	-	-	48
By sedimentation and filtration.	63	73	94	90	-	-	90
By filtration,	22	50	91	82	-	-	81

Yeast Wastes.

The fact that the wastes from a yeast works greatly impaired the efficiency of a sewage-disposal area led to investigations as regards the processes carried on in making this product, and to experiments upon the waste liquors resulting therefrom. The output of the plant was approximately 50,000 pounds of yeast per month, together with comparatively small quantities of white vinegar. The total daily volume of actual wastes was approximately 16,000 gallons.

The raw stock used at the works consisted of molasses and barley malt. The molasses, diluted with town water, was mixed in certain proportions with a mash of barley malt and water, the combined mixture being stirred and heated in a tank, from which it was then drawn off into a so-called fermenting tank. After the process of fermentation, during which the liquor was cooled and the yeast settled out, most of the supernatant liquor was drawn off and was either discharged directly into the sewer by gravity or pumped into a still and used in the manufacture of vinegar. This liquor, which was called "beer," was pumped into the still during less than two days per week. It was wasted at other times because of insufficient apparatus to handle more than two days' supply. The distillate was stored in tanks and was subsequently filtered through wooden or rattan shavings, during which process it became aerated and changed from a crude form of whiskey into white vinegar. The heavy residue in the still, amounting approximately to 2,500 gallons, was discharged gradually during the process of distillation directly into the sewer. On the days when vinegar was made, the still was usually in operation for a period of from eight to twelve hours.

The yeast which settled out in the fermenting tank, together with what was left of the beer, was pumped into two washers, where it was diluted with water and allowed to stand. After the yeast settled out the supernatant liquor, including some of the beer, so called, was discharged into a cistern in the rear of the building. This waste water was called the "primary wash." More water was then added to the yeast, and, after another period of settling, the supernatant liquor or wash water, so called, was discharged into the cistern. The yeast was usually washed in this manner at least five times, — never more than six times, it was claimed.

The only other waste waters resulting from the manufacture of the yeast consisted of (1) water containing small amounts of lime which had been used in washing out the tanks, (2) press liquor and water used in washing the press cloths, (3) floor washings, and (4) cooling water. In addition to the various liquid wastes, there was a small quantity of dry

residue from the tank in which the barley malt mash was prepared. This was sold to farmers for 5 cents a bushel. All of the liquid wastes, with the exception of the "beer," the concentrated liquor from the vinegar still and the cooling water, entered the cistern; the "beer" and concentrated liquor were discharged into the sewer and the cooling water into the swamp east of the factory. The quantity of the various wastes was as follows: —

	Gallons per Day.
Yeast liquor ("beer"),	3,500
Heavy residue in vinegar still,[1]	2,500
Primary wash,	1,500
First wash,	2,200
Second wash,	2,200
Third wash,	2,200
Fourth wash,	2,200
Fifth wash,	2,200
Total,	18,500

In November, 1908, samples of two classes of waste were collected frequently and sent to the experiment station for analysis, and several small filters were started with mixtures of these wastes. Neither the wastes from the still nor those from the yeast washings were of a putrescible character, and that difficulty would be encountered in bacterial purification of such liquids was thus foreshadowed.

Three filters were put into operation, two of them containing 3½ feet in depth of sand of an effective size of 0.25 millimeter and the other containing practically the same depth of clinker. The first filter (No. 359) was operated at the rate of 25,000 gallons per acre daily, and at first received the wastes mixed in equal proportions, but after November 16 the proportion was 1 part of still liquor to 2 parts of yeast washings, and the rate was increased to 50,000 gallons per acre daily. Soon after starting this filter the wastes became acid on standing, and were made alkaline with lime before application to the filter. This filter was operated for four months, but, with the exception of some slight nitrification at first, its only action was practically that of a strainer. By the straining action about 50 per cent. of the organic matter was removed from the applied waste.

The second filter (No. 364) was started at a rate of 50,000 gallons per acre daily, and received a mixture of 95 per cent. Lawrence sewage and 5 per cent. of the mixed waste from the yeast factory. After two months' operation the percentage of waste in the mixture was increased to 7½

[1] Once or twice a week.

per cent. This waste was neutralized with lime for a time, but after February 13 this addition of lime was omitted. After about six weeks' operation the filter began to nitrify well and the nitrates increased from time to time. Attempts to increase in the applied liquor the proportion of waste from the factory above that stated were followed on each occasion by a very great reduction in the nitrification. The filter containing 3 feet in depth of clinker accomplished practically no purification. In a sand filter to which this waste was applied after mixture with septic sewage sludge, and after a long period of rotting, nitrification did not occur, although 50 per cent. of its organic matter was removed.

The average analyses of the two classes of wastes as taken at the factory, of the waste applied to and of the effluents from the filters described above follow: —

Average Analyses.

Outlet of First Tank or Still.

[Parts per 100,000.]

Solids.			Ammonia.			Kjeldahl Nitrogen.	Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
				Albuminoid.						
Total.	Loss on Ignition.	Fixed.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
3199.0	2462.5	736.5	4.37	30.63	28.43	49.83	-	-	800.7	-
Yeast Washings.										
775.4	650.4	125.0	1.18	6.42	5.15	9.88	-	-	142.0	-
Waste Liquor applied to Filter No. 359.										
-	-	-	1.89	12.40	-	-	-	-	352.1	30,010,000
Effluent from Filter No. 359.										
-	-	-	1.89	6.46	-	-	0.24	.0213	150.0	4,133,500
Waste Liquor applied to Filter No. 364.										
-	-	-	3.70	1.14	-	-	-	-	19.4	1,656,600
Effluent from Filter No. 364.										
-	-	-	0.72	0.19	-	-	1.41	.0009	2.46	169,679

From further experiments made at Lawrence with these wastes it was determined that, by a period of sedimentation of two hours, about 25 per cent. of the organic matter present in this waste settled out, and

that this amount was increased little, if any, by longer periods of sedimentation; that by sand filtration, or by straining of the supernatant waste after sedimentation at a rate of 100,000 gallons per acre daily, between 40 and 50 per cent. of the remaining organic matter could probably be removed. This was shown by means of a small sand filter (No. 379) constructed of 3½ feet in depth of sand of an effective size of 0.26 millimeter. The average analysis of the waste applied to and of the effluent from this filter follow: —

Waste Liquor applied to Filter No. 379.

[Parts per 100,000.]

Free Ammonia.	Albuminoid Ammonia.	Oxygen Consumed.
1.30	7.80	134.00
Effluent from Filter No. 379.		
0.70	2.90	85.00

Wastes from a Cotton Batting Factory.

The product of this company consisted of cotton batting and various grades of cotton cloth as well as gauze and surgeons' supplies. The stock used was raw cotton and cotton cloth as it came from the manufacturer, and the processes carried on at the mill consisted largely of washing, bleaching and dyeing. The various processes were found to be somewhat as follows: the cloth or cotton was first boiled in large iron kettles with small amounts of ammonium hydrate, after which it was thoroughly washed, there being usually two distinct washings. After these washings the goods were bleached with chloride of lime and were again thoroughly washed. The stock was then soaked in an acid bath to neutralize any of the bleaching solution which might have remained in the cloth, and was again washed two or three times. It was finally boiled for a second time with soap, and then washed again two or three times, depending on whether the stock consisted of cloth or cotton. The cotton stock was usually given a second acid bath after the second boiling just referred to, and was then washed three or four times to make sure that no acid was left in the goods. In addition, some dyeing was done, but this portion of the work was carried on at irregular intervals, and the amount of stock so treated was small. Liquid wastes resulted from practically all of the processes, and the wash waters and spent dye solutions were discharged directly into the river. The total daily amount of wastes discharged amounted approximately

to 50,000 gallons. The worst wastes to be discharged directly into the stream were the water used in boiling the stock with ammonium hydrate and that used in boiling the stock for a second time with soap. Measurements of the daily quantity of these wastes, made in 1908, were as follows: —

	Gallons.
Water in which stock had been boiled with ammonium hydrate,	3,800
Water in which stock had been washed after being boiled,	7,600
Spent bleaching solution,	1,000
Water used in washing stock after it had been bleached,	9,000
Spent acid solution,	1,000
Wash waters used after acid bath,	9,000
Water in which stock was boiled for a second time with soap,	4,000
Water used in washing stock after second boil,	9,000
Acid bath used on cotton stock,	500
Wash water used after second acid bath on cotton stock,	6,000
Total,	50,900

Spent dye liquors and wash waters amounted to from 5,000 to 10,000 gallons per day.

During 1906 samples of the wastes were collected at the mill and sent to the experiment station. The strongest of the wastes (the first and second boiling of the stock) were mixed and applied to a filter (No. 311) constructed of 3 feet in depth of sand of an effective size of 0.25 millimeter, at a rate of 50,000 gallons per acre daily. On several occasions mixtures of all the wastes were applied to this filter. By the mixture of the strong wastes considerable soap was generally precipitated, and a fairly clear, supernatant liquor obtained. When the filter was operated with a mixture of the two strongest wastes, and with a mixture of all the wastes, the effluent from the filter was clear, colorless and non-putrescible, and the filter removed 73, 89 and 91 per cent. of the organic matter in the applied waste, as shown by loss on ignition, albuminoid ammonia and oxygen consumed results, respectively. The average analysis of the waste as received, of the waste applied to and of the effluent from the filter follow: —

Waste.	Total Residue.	Total Loss on Ignition.	Ammonia.		Nitrogen as —		Oxygen Consumed.
			Free.	Albuminoid.	Nitrates.	Nitrates.	
Raw,	292.6	69.6	.1887	.6835	–	–	10.85
Applied,	249.4	54.8	.1210	.5660	–	–	8.85
Effluent,	182.1	14.8	.0334	.0614	.04	.0046	0.84
Percentage removal,	27	73	72	89	–	–	91

The experiments indicated that the wastes being discharged into the river could be satisfactorily purified after sedimentation by filtration through sand at a rate of 50,000 gallons per acre daily.

Wastes from Silk Mills.

Experiments were made also upon the disposal and purification of the waste liquors from a silk mill. The daily volume of sewage or waste liquor from this mill approximated 2,500,000 gallons. This liquor varied much in character at different periods of the day on account of the varying processes carried on in the mill, at one time resembling in appearance domestic sewage and then quickly changing to a bright blue, pink, crimson or other color, due to the discharge of waste dye liquors. In fact, these dye liquors colored the sewage oftentimes to such an extent that it became nearly as highly colored as the dyes in the dye vats.

Besides this coloring matter, a very large assortment of chemicals, etc., was used daily in the mill, a list too long to be given here; but as examples a few are mentioned below, together with the average amount of each used daily: —

	Pounds.
Carbonate of soda,	124
Silicate of soda,	147
Ammonia,	52
Sulphuric acid,	173
Acetic acid,	181
Nitrate of iron,	339
Bichloride of tin,	237
Sulphate of alumina,	60
Sodium phosphate,	235
Glauber's salt,	88
Chloride of lime,	186
Logwood,	80
Dextrine,	1,307
Vegetable gum,	91
Aniline dyes,	156
Soap,	2,000
Muriatic acid,	115
Silk gum, etc., worked off the raw silk and entering the sewage,	1,520

The list prepared by the mill people contained approximately fifty different substances.

Experiments showed that the surfaces of sand filters became clogged quite quickly when this liquor was applied to them, a result due chiefly to the starch, dextrine, soap, silk gum, etc., in the sewage. Experiments

were therefore made to find methods of preliminary treatment of the sewage before applying it to the sand filters. Three methods were tried, namely, a septic tank, a coke strainer and a contact filter. After a preliminary experiment, which showed that the clogging matters could be removed by each of these processes, good-sized experimental tanks and filters were put into operation at the mill.

The septic tank and accompanying sand filter were of such size and capacity that the sewage applied to the septic tank took twenty-four hours to pass through, and the rate attained by the sand filter which received this sewage was 200,000 gallons per acre daily. The coke strainer was operated at first at the rate of 1,200,000 gallons per acre daily, and the contact filter at the rate of 1,350,000 gallons per acre daily, these rates being nearly doubled afterwards. The rates of the sand filters receiving the sewage from the coke strainer and from the contact filter varied from 150,000 to 225,000 gallons per acre daily.

These experiments showed that the coke strainer was the most efficient in removing the clogging matters from the silk liquor, that is, it removed nearly 75 per cent. of these matters; the septic tank removed 50 per cent. and the contact filter about 40 per cent. In each case the resulting liquor was in good condition for purification by sand filtration at the rate stated. Active nitrification in the filters ensued, and their effluents in each instance were generally quite low in color, notwithstanding the bright colors at times of the sewage applied. In spite of the large amount and variety of chemicals allowed to run to waste from the silk mill, the sewage was never sterile, but contained generally at least 3,000,000 bacteria per cubic centimeter.

Wastes from the Manufacture of Illuminating Gas.

Experiments were made also upon the purification of the wastes resulting from the manufacture of both coal and water gas. Taken as a whole, the waste liquor was a very turbid, brownish-black fluid, containing considerable floating oily matter saturated with carbonaceous matters in solution, — hydrocarbons, — and having a heavy sediment of tar. It was soon evident that chemical treatment would be necessary before filtration. Many experiments with both lime and copperas as precipitants were made on the entire mixed liquor, and also on the separate wastes from the water-gas plant and the coal-gas plant. Chemical treatment was successful in coagulating and removing by sedimentation a large percentage of the suspended and dissolved matters in these wastes. Lime at the rate of a ton and one-half per million gallons was effective generally with the wastes from the water-gas plant, but with the wastes from the coal-gas plant more certain results were obtained when

copperas was used in combination with lime, in amounts averaging about a ton to each million gallons of liquor treated. The solid matters in the untreated liquor varied at times from 3,000 to 52,000 parts per 100,000 a large percentage of which was loss on ignition. The total solid matters after chemical treatment were generally less than 100 parts, with from 20 to 40 parts loss on ignition.

The volume of wastes from the process of making water gas varied from 5,000 to 25,000 gallons per day, while the volume of wastes from the coal-gas plant was much less in amount.

A filter containing a mixture of sand and coke, was operated at this plant for several months, taking all the supernatant liquor after treating the entire water-gas wastes with lime, sedimentation and coke straining. The time required for chemical precipitation and sedimentation was generally but little over an hour. The coke strainers were but a few feet square, placed in walls, dividing sections of the settling tank. The filter was operated at rates from 500,000 to 2,000,000 gallons per acre daily, and although the latter rate was too great to allow much change in the liquor, still many of the odors were removed while it passed through the filter. The resultant liquor was generally fairly clear, with little odor and with total solids and loss upon ignition low.

The experiments indicated that there should be but little difficulty in purifying these gas wastes sufficiently by chemical precipitation and rapid filtration or straining. Filtration after chemical treatment at rates up to 700,000 or 800,000 gallons per acre daily should produce a clear liquor with little odor and but a small percentage of the original polluting matters. Aeration of this liquor before filtration aids materially the removal of odors.

Wastes from a Finishing Company.

The wastes from the mill of this company came from the processes used in the bleaching and dyeing of cotton cloth and in the dyeing of skein yarn. Khaki was treated to a considerable extent and also some heavy duck cloth. The volume of wastes from the bleachery, or old part of the mill, figured from the measurements taken during the summer of 1909, was about 140,000 gallons per day of ten hours, although this amount was apt to vary considerably. The wastes included lime-boil liquor, soapy solutions, dirty rinse waters, some acid wastes and rinse dye liquor. During a large part of the year, when the water in the stream was low, the wastes from the mill gave it an extremely dirty appearance. Under normal conditions the output of the bleachery was about 40,000 yards of cloth per day.

A new building was erected in the spring of 1909 for the dyeing of

skein yarn and raw cotton. Soon after, this part of the mill was put into operation, and samples and measurements were taken of the wastes, which consisted of spent dyes and wash waters. Between 80 and 90 per cent. of these wastes was rinse water and was not very objectionable. The wastes from this part of the mill varied considerably in amount from day to day, depending upon the condition of business. During the summer of 1909 separate systems of piping were laid under the new building for the separation of the objectionable wastes from the rinse waters. The total quantity of wastes from this part of the mill when the measurements were taken amounted to about 500,000 gallons per day of ten hours, but several changes made since that time have tended to decrease the discharge. At the time investigations were made at the plant this department of the factory was shut down.

Frequent examinations were made at the mill during the summer of 1909, and samples were collected from the bleachery, or older portion. These samples were taken from the various machines, and were representative, so far as possible, of the waste liquor entering the brook. For about four and one-half months samples of the wastes from this mill were shipped to the experiment station for analysis. The wastes as received were, in a general way, non-putrescible, very turbid and contained a large amount of flocculent precipitate. The supernatant liquor resulting from the settling of this precipitate was applied from May 29 to September 22 to a filter (No. 374) constructed of 4½ feet in depth of sand of an effective size of 0.26 millimeter, at a rate of 50,000 gallons per acre daily. The effluent from the filter was invariably clear, colorless and non-putrescible, and contained but a small part of the organic matter in the applied waste.

The following table gives the analysis of the waste as received at the station, of the supernatant waste applied to and of the effluent from this filter. It will be seen that the effluent from the filter contained only about 11 per cent. of the original organic matter in the waste, as shown by the albuminoid ammonia determinations, and about 15 per cent. of the amount in the waste applied. The removal of carbonaceous organic matter, as shown by the oxygen consumed determinations, was very great, the effluent from the filter containing only about 4 per cent. of that in the waste as received, and 10 per cent. of that in the waste as applied to the filter. The filter was in good condition at the end of the experiment and it was evident that this waste could be efficiently purified by settling tanks and sand filters.

Average Analysis of Waste as Received.

[Parts per 100,000.]

Solids.			Color.	Ammonia.			Nitrogen as —		Oxygen Consumed.
					Albuminoid.				
Total.	Loss on Ignition.	Fixed.		Free.	Total.	In Solution.	Nitrates.	Nitrites.	
338.0	142.7	195.3	–	.3452	.6727	.5055	–	–	42.57

Average Analysis of Waste applied to Filter No. 374.

247.4	99.3	148.1	–	.1275	.4517	.3063	–	–	21.83

Average Analysis of Effluent from Filter No. 374.

–	–	–	.79	.1850	.0891	–	.02	.0002	2.12

Waste Liquors from Dyeing, Bleaching and Mercerizing Cotton Yarn.

Upon investigation at the plant where these processes were carried on it was found that the total amount of waste water discharged was about 60,000 gallons per twenty-four hours. Of this total, about 25,000 gallons represented the worst of the wastes, namely, (1) water in which the yarn was boiled with soda ash; (2) spent heavy dye liquor; (3) heavy rinse water from dyeing; (4) hot rinse water after mercerizing; (5) hot soap bath after bleaching; and (6) cold rinse after the soap bath. A composite waste, representing a combination of these six wastes in the right proportions, was used in the experiments. Two filters (Nos. 318 and 319) were put into operation at the station and to them the average waste was applied. Each filter contained 3 feet in depth of sand of an effective size of 0.25 millimeter and was operated at the rate of 50,000 gallons per acre daily, Filter No. 318 receiving the supernatant waste after sedimentation and Filter No. 319 the supernatant waste after treatment with chemical precipitants. The average waste was brown in color, very turbid, and but a small portion of the matters in suspension settled readily. The effluent from Filter No. 318 was straw-colored and had but slight odor. This filter removed 56, 87 and 90 per cent. of the organic matter in the applied waste, as shown by loss on ignition, albuminoid ammonia and oxygen consumed determinations, respectively. The effluent from Filter No. 319 was of slightly better

quality than that from Filter No. 318, Filter No. 319 removing 69, 87, and 89 per cent., respectively, of the organic matter in the applied waste, as shown by the determinations just mentioned.

The average analyses of the raw waste, of the waste applied to and of the effluents from these filters follow: —

Filter No. 318.

Waste.	Total Residue.	Total Loss on Ignition.	Ammonia.		Nitrogen as —		Oxygen Consumed.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Raw,	453.2	101.7	.1450	1.4900	–	–	32.30
Applied,	456.8	104.3	.2050	1.5300	–	–	33.10
Effluent,	332.4	45.5	.1016	0.2037	.02	.0198	3.45
Percentage removal: —							
By filtration,	27	56	50	87	–	–	90

Filter No. 319.

Waste.	Total Residue.	Total Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.	Oxygen Consumed.
Raw,	506.8	64.6	.0900	0.9200	–	–	18.40
Applied,	503.6	49.4	.1900	0.6200	–	–	11.60
Effluent,	365.1	15.5	.0540	0.0807	.07	.0017	1.27
Percentage removal: —							
By precipitation,	1	24	–	33	–	–	37
By precipitation and filtration.	28	76	40	92	–	–	93
By filtration,	28	69	72	87	–	–	89

Shoddy Mill Wastes.

During 1906 experiments were made upon wastes from a mill manufacturing goods from rags. From 60,000 to 70,000 gallons of waste liquor were discharged from this mill daily. Processes for carbonizing, washing and dyeing rags were carried on at the plant, and the wastes discharged were those resulting from washing the rags after carbonizing, and also the spent dye liquor from dyeing. Hematine dyes were used, and as the amount of dyeing at the mill during this year was comparatively small, the wastes from this process were insignificant. The carbonizing process consisted in treating the rags with a solution of sulphuric acid. The waste water and the wash water from washing the rags after carbonizing were dirty and contained a considerable amount of sulphuric acid. From 250 to 1,200 pounds of lime per million gallons of waste were required to neutralize it, or about 20 to 100 pounds for the volume of waste discharged. The waste as received at the sta-

tion contained considerable heavy black sediment, but the supernatant liquor was fairly clear, and the addition of lime caused still further clarification. The supernatant waste after neutralization was applied for two months to a filter (No. 302) containing 3 feet in depth of sand of an effective size of 0.28 millimeter, at a rate of 100,000 gallons per acre daily. The effluent from this filter was clear, colorless, non-putrescible, and nitrification was active. The average analyses of the waste as received, as applied to the filter and of the effluent from the filter are given below, and it will be seen that by sedimentation and filtration 75, 88 and 85 per cent. of the organic matter in the applied waste, as shown by loss on ignition, albuminoid ammonia and oxygen consumed determinations, respectively, was removed: —

Filter No. 302.

Waste.	Total Residue.	Total Loss on Ignition.	Ammonia.		Nitrogen as —		Oxygen Consumed.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Raw,	71.7	36.9	.6400	.4300	–	–	4.39
Applied,	53.6	10.1	.6225	.1298	–	–	1.94
Effluent,	61.1	9.4	.0176	.0534	1.01	.0419	0.67
Percentage removal: —							
By sedimentation,	25	72	3	70	–	–	56
By sedimentation and filtration.	15	75	97	88	–	–	85
By filtration,	–	7	97	59	–	–	65

In 1908 further experiments were carried on with the wastes from this mill, as it was said that the process by which the stock was treated in order to remove cotton, etc., had been changed. In removing the cotton two processes were employed at this time; the greater part of the rags, however, were treated as follows: the rags sorted as to color were torn into small pieces and soaked in a bath of cold sulphuric acid for about three hours. The strength of this bath varied from 6 to 9° Beaumé for different kinds of cloth; that is, the bath contained 7 to 10 per cent. sulphuric acid. The rags were then removed, drained and partly dried in a centrifugal drier. The drying was finished in steam-heated vats at about 200° Fahrenheit, the cotton present being carbonized by this process. The driers were not ventilated and the moisture was condensed on pipes in which cold water circulated. When dry, the cloth was taken to dusters, by which the carbonized cotton was separated from the wool as a fine dust, to be drawn off by a suction fan and deposited near the boiler room where it was burned. After this the cloth was washed from

fifteen to twenty minutes in a machine like a paper-machine washer, and carbonate of soda was stated to be added in quantities sufficient to neutralize the acid. Other rags were treated by a process in which a warm ammonium chloride bath was used instead of a bath of sulphuric acid. The rest of this second process was practically the same as that just described, except that the washing was done without the addition of sodium carbonate. Only a small amount of the stock underwent this second treatment, however, when it was desired to keep a black color.

The wastes were supposed to be neutral or slightly alkaline on account of the addition of sodium carbonate, but it was soon evident that the waste when discharged was still generally acid. The waste as it came from the mill contained a small amount of matter in suspension, which settled very rapidly, leaving a clear liquor. This clear liquor was passed through a sand filter at the experiment station, first at the rate of 100,000 gallons per acre daily and later at a rate of 150,000 gallons per acre daily, with a satisfactory, well-nitrified effluent as a result. Before application to the filter the acid wastes were neutralized by the addition of lime in order to ensure good purification.

The following table presents the average analysis of the waste as it came from the works, after clarification by sedimentation, and of the effluent from the filter: —

Average Analysis of Raw Waste, Waste applied to and Effluent from Filter.

[Parts per 100,000.]

	Color.	Ammonia.		Chlorine.	Nitrogen as —		Oxygen Consumed.	Hardness.
		Free.	Albuminoid.		Nitrates.	Nitrites.		
Raw waste,	–	.9483	.4087	–	–	–	3.05	–
Applied waste,	–	.8000	.1280	3.15	–	–	1.02	12.95
Effluent,	0.23	.0836	.0592	3.93	1.28	.0022	0.79	1.45

Glue Wastes.

Experiments were made during 1908 and 1909 upon the wastes from a glue factory. The stock used at this plant was of three kinds, consisting of two grades of salt stock (fish skins, heads and bones) and fresh fish heads. All three grades were washed before use. After being washed, the best grade of salt stock was cooked in open kettles, while the poorer grade of salt stock and the fresh stock was heated with live steam in closed iron digesters. The results of the cooking in each case consisted of glue liquor and a solid residue. The glue liquor was evaporated and treated in various ways to form the finished product, while the solid

residue was pressed and dried, being shipped finally in bags to fertilizer manufacturers. The liquid wastes resulting from the various processes amounted to about 120,000 gallons a day, divided as follows: (1) from skin washers; (2) from fresh fish cookers; (3) from salt fish cookers; (4) floor washings; (5) condenser water; (6) purifiers; and (7) the domestic sewage from 115 operatives. The main sewer of the factory received all this waste at various points and discharged it into a brook below the storage basin of the plant for condenser water. These wastes were putrescent and had strong and offensive odors.

Two filters (Nos. 368 and 370) were operated at Lawrence with the waste. Filter No. 368 was constructed of 4 feet in depth of sand of an effective size of 0.25 millimeter, and received the mixed strong wastes at a rate of 25,000 gallons per acre daily at first and later at a rate of 50,000 gallons per acre daily. The effluent from this filter was always non-putrescible, clear, colorless, odorless, and nitrification was high; but notwithstanding high nitrification the free ammonia in the effluent was also very high, owing to the large amount of nitrogenous bodies present in the applied waste. Filter No. 370 was operated as a trickling filter and was constructed of 6 feet in depth of broken stone of the size most successfully used in trickling filters at the station, and was operated at a rate of 500,000 gallons per acre daily for a month and then at a rate of 750,000 gallons per acre daily. Nitrification began almost immediately in this filter, and the amount of nitrates present was as great as that in the effluent from the sand filter, which was operated at from one-tenth to one-fifteenth as great a rate. The amount of free ammonia present, however, in the effluent from this filter was only one-half as great as in the effluent from the sand filter, this result being due largely, however, to the fact that the wastes obtained from the works were weaker during the period of operation of this filter than during the entire period of operation of the sand filter. The effluent from the trickling filter was practically odorless, stable and of a character equalling in most respects that from trickling filters receiving domestic sewage.

The average analysis of the waste liquor applied to and of the effluents from the two filters follow: —

Average Analysis of Waste Liquor applied to Filters Nos. 368 and 370.

[Parts per 100,000.]

Color.	Ammonia.		Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.	Nitrates.	Nitrites.		
–	14.22	5.59	–	–	8.77	2,730,000

Effluent from Sand Filter No. 368.

[Parts per 100,000.]

Color.	Ammonia.		Nitrogen as —		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.	Nitrates.	Nitrites.		
.36	12.83	0.27	5.25	.4896	0.86	5,000

Effluent from Trickling Filter No. 370.

.50	6.96	0.66	5.26	.0498	3.15	502,000

Paint Mill Wastes.

Investigations in regard to wastes from a paint factory were made during 1902, 1903 and 1904 as the result of an application in November, 1902, from a local board of health, in which it was stated that much complaint had been made to them concerning the contamination of a lake and connecting brooks by the wastes from certain paint mills. The lake was not a source of water supply, but ice was cut from it in winter and in summer it was used by the students of a girls' college for boating and bathing, the boat-house, bath-house and swimming-float being about 250 yards from the outlet of the brook into the lake. These wastes caused the brook to be badly colored oftentimes. The lake, too, became colored to some extent, and with the wastes a large amount of lead was carried into these waters. Mineral paint, so called, was made, chrome iron ore being the basis. This was mixed with lime or sodium carbonate, or both, and heated, and the sodium chromate formed was passed into solution. This material was then treated in large tanks with lead acetate and sodium bichromate, lead chromate being precipitated, and this yellow body formed the main portion of the paint shipped from the works. Sulphuric acid was added to the tanks at times to vary the shade of yellow formed. Lead acetate was made at the plant by allowing acetic acid to pass over lead. Blue paint was made by treating the lead chromate with Prussian blue, and green paint by mixing the yellow and the blue. A red paint was also made of the lead chromate by treating it with aniline dyes. The only acids said to be used around the works were acetic, nitric and sulphuric. Neither arsenic nor mercury was used. The lead chromate, after being precipitated, was pressed in filter presses and then mixed or ground with oil. No oils were supposed to be allowed to run to waste from the grinding room. Kerosene was used, however, to prevent scale in the boilers, and the exhaust contained some oil which was blown off into the brook.

The lead chromate was precipitated in large tanks, and after sedimentation the supernatant liquor was allowed to run to waste. In the main precipitating room, or "yellow house," there were four tanks which held about 7,000 gallons each, and which were generally emptied once a day, approximately 25,000 to 28,000 gallons of waste liquor passing from them. From the shop in which the blue paint was made practically the same amount of liquor passed into the brook each day, and from the shop in which green paint was made about 2,000 gallons per day. Considerable water was pressed from the precipitate when it was treated in the filter presses, and this waste water was also allowed to run into the brook. It was of course the aim to allow as little color or lead to flow to waste as possible, but there was not sufficient care taken, as was shown by the examinations made.

Samples of the waste from the mill, of the brook and of the lake water were analyzed. Two samples of wastes collected in January, 1903, showed 250 and .03 parts of lead per 100,000, respectively. The analyses of samples of water from the brook when wastes were flowing from the mill and from various parts of the lake itself showed the presence of large amounts of lead. A mixture of various samples of the wastes was made and the amount of lead determined. It was found that about 150 pounds of lead passed from the mill each day in the waste liquors, this amount of lead, according to figures furnished at the mill, meaning a waste of $2,300 worth of lead per year. A sample of ice cut from the lake showed a lead content of .009 part per 100,000. Every acre of water in the lake 1 foot deep contained at the time of this investigation about 2 pounds of lead, making the upper foot of lake water contain about 282 pounds, the lake being 141 acres in area. Deposits in the brook and at the entrance of the brook into the lake also contained large amounts of lead. Experiments upon sedimentation showed that if suitable sedimentation tanks were provided a very large percentage of the lead wasted could be saved and prevented from polluting the lake water, and that the saving of the lead would eliminate the color of the wastes. At the end of 1903 further examinations were made, and samples from the brook showed 3.33 parts of lead per 100,000; a sample collected from the drain entering the brook showed 36.40 parts per 100,000.

As a result of the first investigations the paint company agreed to erect tanks at their works in order to save much of the lead chromate, etc., that was wasted. The mill was visited again in August, 1904, the brook and lake were examined and samples were collected for analysis. It was found at this time that the appearance of the brook was considerably improved; the lake seemed to be free from colored matter, and at the mill, tanks had been erected to save the wastes from that portion of

the mill in which green paint was made. Much lead was saved by these tanks and little wasted from them. No provision had been made to save the yellow wastes, a considerable flow of which was passing into the brook at this time. Samples taken from the brook, lake and wastes from the drains discharging yellow lead chromate at this time were collected and analyzed for lead, with the following results: —

[Parts per 100,000.]

Source.	Lead.	Source.	Lead.
Brook,	0.0600	Outlet of lake,	0.0800
Swimming-pool at the college,	0.0800	Yellow wastes from the drains,	5.6000[1]

[1] 3.4 parts lead in this last waste was in suspension.

THE COLLECTION AND DISPOSAL OF MUNICIPAL REFUSE.

By X. H. GOODNOUGH, CHIEF ENGINEER.

THE COLLECTION AND DISPOSAL OF MUNICIPAL REFUSE.

While there has been a marked improvement in recent years in many branches of municipal service having to do with the public health and comfort, the methods of disposal of refuse in American cities and towns are still for the most part inefficient and unsatisfactory. The objections to the methods used have in many cases long been recognized by municipal health authorities, but the difficulty and cost of improving them, and especially the uncertainty of the results obtainable by any of the methods which have hitherto been available, have caused hesitation in the making of changes and delayed the introduction of the necessary improvements, a delay which has been to a considerable extent justifiable and perhaps not wholly unfortunate. It is proposed here to review briefly present conditions and describe the methods available for the disposal of municipal wastes and the results which may be expected from them.

CLASSIFICATION OF MUNICIPAL REFUSE.

The materials ordinarily included in the term "municipal refuse" are classifiable generally as follows: —

1. House offal or garbage.
2. Ashes and house dirt.
3. Waste and rubbish, chiefly wood, paper, etc.
4. Market refuse.
5. Street sweepings.
6. Cesspool and catch-basin cleanings.

Earth excavations and other wastes from building operations are a considerable item of city waste, and, while their removal is regulated, their disposal is not commonly undertaken by cities and towns. Stable manure is often included in the wastes to be dealt with by the municipality, though not ordinarily in large quantities in Massachusetts cities. The disposal of snow, an important problem in the larger cities and towns, is sometimes carried on in connection with the collection of other city refuse, but it does not ordinarily seriously affect the problem of city waste disposal. The disposal of dead animals and of slaughterhouse

refuse is usually, in Massachusetts at least, undertaken by rendering or fertilizer establishments operated by private parties, generally under regulation by the municipality. Waste meats from markets are collected and disposed of for the most part by rendering companies, with establishments near the larger cities. The collection and disposal of sewage, one of the most important of municipal wastes, is a separate problem.

Sources of Municipal Refuse, Separation and Method of Collection.

Garbage or house offal is chiefly waste food from the kitchens of dwelling houses, hotels and restaurants, and, as it consists almost wholly of putrescible organic matter, it is subject to rapid decomposition and capable of becoming very offensive. In nearly all Massachusetts cities and towns it is kept separate from other wastes, and separation is in most cases enforced as fully as practicable by city ordinance. Garbage ordinarily contains numbers of bottles, tin cans and other food packages, which in some cities are classified with the garbage, as well as oyster shells and other substances, though usually in small quantities.

Garbage is ordinarily collected and removed to the place of disposal in carts used for that purpose only. Collections from dwelling houses are usually made once a week in winter and twice a week in summer, though in densely populated districts collections are sometimes made more frequently, while the garbage of hotels and restaurants in the cities is usually removed daily in the summer season.

The refuse classified as ashes includes ordinarily the sweepings of floors of dwelling houses, stores and offices, and of cellars, yards and areas. This class of refuse also includes usually much other household refuse, such as packing materials, wood and paper boxes, waste paper, bottles, tin cans, rags, old shoes, broken furniture, mattresses, etc.

In some cities a third separation, so called, is made by requiring the householder or storekeeper to keep certain of the wastes, mostly combustible, separate from the ashes, with a view to separate disposal. This third separation is usually confined to the business portion of cities, and the materials classified under it in the down-town section of the city of Boston, for example, are indicated by the following notice: —

Garbage.

All vegetable matter.

Sauce bottles.

Only catsup and other sauce bottles should be put into the garbage can; all other bottles into the paper barrel.

Tin cans.

Fruit, vegetable and meat cans should be put into the garbage can; other cans into paper barrel.

Ashes.

Sawdust.

Broken bottles.

Broken glass.

Broken crockery.

Floor and street sweepings.

Oyster and clam shells.

Tobacco stems.

Paper.

Bottles.

Rags.

Tin cans.

Excelsior.

Straw.

Mattress.

Old cloth.

Pasteboard boxes.

Old shoes.

Leather and rubber scraps.

Carpets.

Combustible refuse generally.

Ashes from coal used in making steam at heating plants, factories, etc., are usually clean and free from infectious matter, but the ashes from dwelling houses, hotels, stores, etc., are ordinarily mingled with the sweepings of floors and with much other refuse, including, often, more or less garbage and organic matter.

Ashes and house dirt are usually collected by the municipality in carts used for that special purpose, which are similar to the carts used for the collection and removal of street sweepings. In cities in which the third separation is in force specially designed carts of large capacity are used for the removal of combustible refuse.

Market wastes, consisting chiefly of decayed fruits and vegetables and sometimes of condemned meats, — mingled usually with packing materials, — are capable of being very offensive, and their satisfactory disposal is in some cases a difficult problem. They are usually removed by the proprietors of the markets and disposed of with the ashes, but their disposal is usually undertaken or directed by the city.

Street cleanings form a very large item of municipal waste. From well-paved streets they consist largely of manure, waste paper, etc., while from macadamized roads they contain large quantities of inorganic matter. Cleanings from catch-basins consist very largely of sand, usually mingled with much foul organic matter.

Quantity of Municipal Wastes of the Various Classes.

The records of quantities of garbage, ashes and other wastes collected in the various cities are not commonly kept in such a way that the actual volume and weight of these wastes can be determined with great accuracy; but in the larger cities the records in more recent years are complete enough to furnish a very close approximation as to the volume and weight of the materials removed. In order to show the quantity of waste of various kinds collected in a large city and the quantities collected in its various districts, the following table is presented, showing the amount of the various wastes collected in the sanitary districts of the city of Boston in the year ending Jan. 31, 1910: —

Table showing Quantity of Refuse collected in the City of Boston during Year ending January 31, 1910.

Material.	Quantity (Tons of 2,000 Pounds).	South Boston. 1 (73,000)	East Boston. 2 (57,000)	Charlestown. 3 (40,000)	Brighton. 4 (25,000)	West Roxbury. 5 (40,000)	Dorchester. 6 (105,000)	Roxbury. 7 (117,000)	South End and Back Bay. 8 and 9 (104,000)	North and West Ends. 10 (77,000)	Totals. (638,000)
		Names, Numbers and Estimated Populations of Sanitary Districts.									
Ashes,	Total for year,	22,688	19,372	16,281	13,744	22,847	40,197	37,383	73,695	65,584	311,791
	Average per day,[1]	73	62	52	44	73	129	120	236	210	999
	Pounds per capita per day,[1]	2.00	2.18	2.60	3.52	3.65	2.46	2.05	4.54	5.51	3.13
House offal,	Total for year,	4,905	3,310	2,647	3,535	4,891	10,743	10,479	19,667	8,459	68,636
	Average per day,[1]	16	11	8	11	16	34	34	63	27	220
	Pounds per capita per day,[1]	.44	.38	.40	.88	.80	.66	.58	1.21	.70	.69
Waste and rubbish,	Total for year,	200	–	–	–	13	–	584	6,281	3,838	10,916
	Average per day,[1]	1	–	–	–	–	–	2	20	12	35
	Pounds per capita per day,[1]	.03	–	–	–	–	–	.03	.39	.32	.11
Market refuse,	Total for year,	–	–	–	–	–	–	–	–	4,977	4,977
	Average per day,[1]	–	–	–	–	–	–	–	–	16	16
	Pounds per capita per day,[1]	–	–	–	–	–	–	–	–	.43	.05
Totals,	Total for year,	27,793	22,682	18,928	17,279	27,751	50,940	48,446	99,643	82,858	396,320
	Average per day,[1]	90	73	60	55	89	163	156	319	265	1,270
	Pounds per capita per day,[1]	2.47	2.56	3.00	4.40	4.45	3.11	2.66	6.14	6.96	3.98

[1] Six days per week, 312 days per year.

From the foregoing table it appears that the quantity of ashes per capita is greatest in district 10, that is, in a down-town section of the city containing large office buildings and many manufactories. The quantity of garbage is greatest in districts 8 and 9, which contain many large hotels and restaurants. In the residential districts it is highest in the regions containing the better class of houses. For the whole city the amount of ashes requiring removal each day is 3.13 pounds per capita and the amount of garbage .69 of a pound per capita. In the smaller cities the conditions are not very different from those found in the city of Boston. In most of them, however, the quantity of garbage per capita is somewhat less, partly because a larger proportion of the inhabitants in the smaller cities live in the regions outside of the garbage-collection districts, and the same is true as to the amount of ashes collected in these cities; though in many cases, where the cities contain large manufacturing plants, the amount of ashes removed is greater in proportion to the population than in a large city.

The proportion of the various wastes — ashes, house offal, rubbish and market refuse — varies but little in the different districts. The percentage of garbage is least in the North and West Ends and Charlestown, where it is from 10 to 14 per cent. of the entire wastes; and is greatest in Roxbury, where it amounts to 22 per cent. of the entire wastes. In the other districts there is very little variation. In the entire city the ashes, etc., form about 79 per cent., and the garbage about 17 per cent., of the entire wastes. The proportions vary greatly at different times in the year, however, the quantity of garbage being greatest in the summer and early fall, while the quantity of ashes is greatest of course in the winter.

In the smaller cities and towns the records available show a far greater variation in the proportions of the different wastes, and they also show quite a wide variation in the quantity of wastes per capita. These differences are no doubt due in part to local conditions, but they are probably due largely to the methods of keeping the records, which in some places are not very reliable.

Methods of Disposal at Present in Use.

Garbage. — Garbage or house offal is ordinarily the first of the municipal wastes to require attention from the local authorities in a growing town, and the common method of disposal adopted is to use it for feeding swine. A recent investigation shows that this method is employed in 28 cities and 33 towns in Massachusetts, or in a total of 61 out of the 71 cities and towns in the State in which the collection and disposal of garbage is carried on or regulated by the municipality.

The disposal of garbage by feeding to swine probably costs less, under

Large Dump. Material being used to fill Flats near Tidal Estuary. Floating Refuse carried to Other Shores by the Tides.

Large Refuse Dump near the Seashore. A Resort for Children and Ragpickers.

the existing conditions about most of the cities, than any other available method, and this is its only advantage. This advantage is, nevertheless, an important consideration in reconciling city and town authorities to the continued use of this method. It is objectionable and unsanitary in the extreme, as health authorities are constantly pointing out, but without sufficient support from municipal governments or public opinion to secure a satisfactory change. Prominent among the objections to this method of garbage disposal are the great nuisance it usually creates and the uncertainty of its operation. Where garbage is disposed of by feeding to swine it not infrequently happens that an epidemic among the pigs destroys great numbers of them in a short time, and the garbage then accumulates and must be disposed of by some temporary method hastily devised, — usually by dumping it into some adjacent water or on the most readily available land, with more or less objectionable results. Difficulties of this sort also not infrequently interfere with the regularity of the collection of these wastes, with the result that they are left to decompose in the neighborhood of dwelling houses. Of the great nuisances caused by piggeries where large quantities of municipal garbage are used no description is necessary, and in many cities and towns such places are not tolerated, one of the conditions commonly imposed on the collector of garbage being that it shall be removed beyond the limits of the municipality.

Aside from the nuisance which piggeries create, one of the most serious objections to them is the fact that they are the breeding places of myriads of flies and other insects, and that they are very often the home of great numbers of rats, which at times infest the neighboring buildings and dwellings. The danger from flies as carriers of disease is well known, and it has been determined that rats and their attendant parasites are probable agencies in the spread of the plague.

In Massachusetts communities the disposal of garbage by dumping at sea or on land is practiced only to a limited extent. The plan of dumping garbage at sea has been tried in many places, but nearly always with unsatisfactory results. For many years a large part of the garbage of the city of Boston was dumped at sea off the mouth of the harbor; but large masses of it drifted at times to the shores of the bay, where it was the cause of much complaint, and the practice was discontinued. At the present time the garbage of the town of Hull, a populous summer resort, is dumped at sea during four months of the year, and a part of the garbage of the city of Lynn is disposed of by this method. It is evident that a portion of the garbage dumped at sea is used as food by birds and fishes, but where dumped in large masses it disperses slowly and may be carried long distances by wind and tide. It is doubtless practicable to dispose of small quantities of garbage by dumping it at

sea in places where it is likely to be carried many miles by the current before it reaches an inhabited shore, but such cases are exceptional.

Dumping on land is practiced only to a very limited extent in Massachusetts. Where the area used is remote from human habitation, and the dump is kept covered with clean earth, it may serve to dispose of small quantities of garbage without its objectionable features becoming very prominent. Such masses, however, decompose slowly, and drainage from them is likely to pollute adjacent waters. Except for small quantities of garbage, the method is a very objectionable one.

Plowing garbage into land may be employed under favorable conditions of soil, etc., with comparatively little objection. It is capable, however, of very limited application, and is used only by two or three small towns in Massachusetts.

When the disposal of garbage by feeding to swine or by dumping on land or at sea becomes impracticable or intolerable, the next step is the introduction of some form of garbage destructor, many varieties of which have been tried in American cities and towns. The design and operation of these destructors vary in detail, but they may be divided into two general classes: (1) crematories, by which it is sought to reduce the garbage to inoffensive clinker and ashes; and (2) reduction plants, by which the garbage is treated for the removal of materials of commercial value and the residue utilized in the manufacture of fertilizers.

Garbage crematories of various kinds have been tried in many cities, but in a very large number of cases they have been found unsatisfactory and have been succeeded by other methods. The objections to these furnaces have been found to be their excessive cost of operation, their limited capacity, the unsatisfactory destruction of the material and the nuisance which they have often created.

Very few attempts have been made to treat garbage by this form of cremation in the State of Massachusetts, and none on any considerable scale. An examination of a garbage crematory introduced not long ago in one of the larger cities for the burning of market wastes, consisting of refuse fruits and vegetables, mingled with large quantities of wood, straw and other packing materials, showed very unsatisfactory results. The refuse was not burned completely, and large masses discharged from the furnace containing unburned material were offensive, and much of it had to be reburned. Smoke and heavy gases generated in the furnace, though discharged at the top of a tall chimney, fell to the ground, and were at times very offensive. The cost of operation was considerable, as coal had to be used; and the operation of a furnace of this sort in or near a populous district, in the manner in which it was being operated at the

time it was examined, would be intolerable. One of the essential defects of these works is the impracticability of maintaining a sufficient degree of heat to secure rapid and complete combustion.

The reduction process is used chiefly for the disposal of garbage in the larger cities, and two such plants are in operation in Massachusetts, one for the disposal of the garbage of the city of Boston and another for that of the city of New Bedford. The reduction method of garbage disposal is controlled by patents, and the works are usually operated by private companies under contract with the city or town. In a few cases, however, such a plant is owned and operated by a municipality, a notable case being the city of Cleveland, O.

This method of disposal is designed to recover from the garbage materials of commercial value for the purpose of reducing the cost of disposal. The garbage is first cooked in closed tanks or digesters for a period of several hours, for the recovery of grease, which is sold for various purposes at prices which have ordinarily ranged from 3 to 5 cents per pound. In average city garbage the quantity of grease recovered may amount to 60 pounds or more per ton of garbage, but there is a great variation in this item. The residue, or tankage, after cooking and the recovery of the bulk of the grease, is subsequently pressed for the removal of moisture and residual grease, and after drying and grinding is sold as a fertilizer base. In quantity it may amount to between 200 and 400 pounds per ton of garbage treated, and when well ground and dried may be worth in the neighborhood of $2 per ton.

The reduction method represents a considerable improvement in the disposal of garbage over feeding to swine or dumping it in large quantities on land or into the sea. One of the chief advantages claimed for it is the saving effected in the cost of disposal of this form of refuse by the recovery of materials of commercial value. The net return obtainable in this way, however, has not been great enough to enable cities and towns to secure the disposal of their garbage by this method without the payment of a considerable sum for the work.

At Boston the garbage is collected by the city and delivered upon scows of the reduction company at wharves maintained by the city on the water front. The total quantity delivered to the reduction company in the year 1909 amounted to 59,898 tons, for the disposal of which the city paid the company a subsidy of $52,400, or about 88 cents per ton, all of the by-products being the property of the company. In municipally operated plants under efficient management the income from the sale of products has in one case apparently been made nearly or quite sufficient to pay the cost of disposal; but none of these works has been in operation a sufficient length of time to give reliable information as

to the average cost of maintenance and operation or the amount of income that can be relied upon.

Reduction plants have often been a source of complaint on account of objectionable odors, and they are usually located at some point well removed from populous districts. The plant in use at Boston is located on an island in the harbor, and that at New Bedford in a very thinly settled district a few miles from the city. In addition to the objections caused by odors, there is a considerable quantity of foul drainage and wash water requiring disposal from such works, which, unless properly treated, may create a nuisance. Danger of nuisance from such plants has thus far required their location in remote districts, which probably adds in many cases to the cost of collection of the garbage.

Considerable improvement has been made recently in the design and operation of reduction works, and it is not certain that they cannot be improved sufficiently to be unobjectionable in some localities. In the recovery of valuable by-products as a part of the process of disposing of a class of municipal waste which contains a very large percentage of moisture and is difficult to treat, the reduction process has certain advantages; but these are at the present time in most cases greatly outweighed by serious defects.

For the best results in the treatment of garbage by reduction efficient separation from other wastes is essential, and this is in some cities a problem of increasing difficulty. Moreover, under present conditions very considerable quantities of putrescible organic matter, especially market refuse, are not included with the garbage, but are disposed of in common with other city wastes. Nevertheless, the reduction method or some modification of it may be improved to such an extent that it may still have a place in the disposal of municipal wastes in this country, either alone or in connection with other methods.

Ashes, Waste and Rubbish. — Clean ashes unmixed with other waste is an excellent filling for low land, and can be dumped on land or at sea without serious objection. But the municipal refuse classed as ashes contains also dirt from the sweepings of floors in houses, stores and offices, and a large quantity of other wastes, especially paper, wood, packing materials, broken furniture, etc., and not infrequently a greater or less quantity of garbage or other organic matter. When refuse of this sort is dumped at sea, the lighter matters, which are capable of floating long distances, often reach inhabited shores and create objectionable conditions; and when dumped on land, unless the dumps are kept carefully covered, as is rarely the case, these dumping places become the source of frequent complaint on account of offensive odors and the smoke

from fires, while the dust and waste paper from these places are often blown long distances about the neighborhood. Such dumps are often the cause of serious pollution of adjacent waters.

Notwithstanding the objections to this method of disposal, it is the common method in use, and with one or two exceptions the only method at present employed in Massachusetts. A large part of the waste of this class from the city of Boston is dumped at sea off the mouth of the harbor, a practice which has been followed for many years; but on account of the increasing complaint due to the fouling of the shores of neighboring towns, the city in 1899 instituted a "third separation," so called, in the districts in which material is collected for dumping at sea. This third separation is designed to keep combustible wastes and certain other matters separate from the ashes and house dirt, and this waste has since 1899 been disposed of by burning in a furnace designed for the purpose located on one of the wharves.

This incinerator plant was constructed by a private company, and is operated under contract with the city, by which the city delivers to the works the combustible waste and refuse from certain districts, free from garbage and other objectionable substances, and pays the incinerator company the sum of $5,500 per year for the work. The city also pays the rent of the wharf on which the works are located, which is also used for other purposes, and defrays the cost of taxes, water rates, etc.

The incinerator consists of a single furnace, using natural draft, and is adapted for the burning of paper, wood and light combustible wastes generally. Similar furnaces have been used in other cities. Attempts have been made to utilize the heat from furnaces of this kind for the production of power; but the power produced has not added materially to the economy of such works.

In the city of Boston the rubbish is delivered at the incinerator plant by city teams, and is then picked over, the salable materials culled out and sold and the remainder burned, the ashes with the incombustible matters being deposited upon the city dumping scows and dumped at sea. The operation of this plant, which is located in the business section of the city, has been unobjectionable, and by its use large quantities of light waste have been kept from fouling the harbor and its shores. The separation of combustible waste from the other wastes, however, is not thorough in the districts in which it is enforced, and in consequence large quantities of combustible waste are still mingled with the ashes discharged at sea, and continue to be a source of objection to the residents of neighboring shores.

In the city of Cambridge an incinerator of different design from that in use in the city of Boston has recently been installed by the city for

burning the refuse from a large district. The refuse delivered to the incinerator consists very largely of combustible waste, and contains considerable ashes but very little garbage.

In a few smaller cities the third separation has recently been put in operation, the combustible wastes being kept separate from the ashes and disposed of by burning in iron cages located upon one or more of the dumps. The amount of combustible waste disposed of in this way, however, is small. In most cities in Massachusetts the great bulk of the ashes and combustible wastes, including also market waste, street sweepings and the cleanings of cesspools and catch-basins, is disposed of upon dumps; and in the larger cities available dumps convenient for the purpose are rapidly becoming filled, and disposal by this plan is involving a continually increasing length of haul.

Market Refuse, Street Sweepings and Other Wastes. — Market refuse is ordinarily disposed of in connection with the ashes and combustible waste, though parts of it are included in many cities with garbage, where it properly belongs. In Boston a part of the market wastes is sent to the reduction works. The remaining wastes of this class from the downtown districts are deposited on dumping scows and dumped at sea, the refuse being hauled to the scows by private individuals and disposed of by the city at a small charge for the work. In other parts of the city the market wastes are either included with the ashes or dumped separately upon the public dumps.

In one of the larger cities an incinerator plant has been provided for the cremation of the market wastes, which are kept separate from wastes of other kinds. This incinerator as operated at present is not very efficient, the wastes are sometimes not thoroughly burned, and the clinker discharged from the furnace contains unconsumed organic matter and sometimes requires reburning. There is also a heavy discharge of foul-smelling smoke from the chimney at times, which makes an offensive odor in the neighborhood.

Street sweepings and the refuse from cesspools and catch-basins are ordinarily disposed of with the ashes. A part of the street sweepings in the city of Boston is dumped at sea, and the remainder is deposited upon dumps in various parts of the city. Street sweepings contain much organic matter, and are of some value for use as a fertilizer and are used to some extent for that purpose. Parts of them, especially the portions collected in the densely populated districts of cities, are of much more value for this purpose than those collected from the more thinly settled areas, and are sometimes shipped long distances and sold to farmers. They can be dumped upon land, if kept moist until covered with clean earth, without serious objection.

Large Dump in Close Proximity to School Building and Private Residence.
Note Number of Persons engaged in Picking over the Refuse.

Refuse Dump in Densely Populated District. Very Offensive on Account of Dust and Smoke.

Disposal of Refuse by Cremation.

In striking contrast to the methods of refuse disposal thus far described are those employed in foreign cities, and especially in the British Isles. After experience with various ineffective methods of disposing of municipal waste, including crematories and incinerators of various kinds, a crematory has been evolved in which mixed refuse of all classes — garbage, ashes, etc. — is burned without nuisance and reduced to inoffensive clinker and ashes. The results obtained from the use of these furnaces have been so satisfactory that they have been installed in a great number of British cities and are being rapidly introduced in other countries. Four furnaces of this type have been introduced in American and Canadian cities, viz., Westmount, P. Q., Staten Island, N. Y., Seattle, Wash., and Vancouver, B. C., while a large one has just been completed for the disposal of the refuse of the city of Milwaukee, Wis.

The essential difference between these furnaces and the crematories and incinerators hitherto employed for the burning of garbage and refuse is the use of forced draft and the attainment of temperatures in the furnaces ranging from a minimum of 1,500° F. to a maximum of 2,500° or more.

The main features of these works, which are known commonly as refuse destructors, are: a furnace containing two or more subdivisions or cells, generally from two to four, each of which has a grate area of about 25 square feet; a system of forced draft, by which air or steam is applied under pressure beneath the grates; a combustion chamber, through which the smoke and gases pass for complete combustion; and usually boilers by which the heat generated is used for the production of power for various purposes, including the operation of the plant, the whole enclosed in a building with a suitable chimney.

The refuse is fed to the grates at the front, back or top of the furnace, and the rate of operation is approximately about half a ton of refuse per square foot of grate area per day; that is, a furnace of three cells, each cell having a grate area of 25 square feet, will have a capacity of from 40 to 50 tons of mixed refuse per twenty-four hours.

The cost of these works varies with the circumstances of the location; but those already constructed in America have cost from $36,000 to $68,000 for a four-cell plant with a capacity of from 50 to 60 tons per twenty-four hours, including building, chimney and all appurtenances. In the case of the higher price the cost of the building was increased by the necessity of the construction of a long approach.

The cost of the operation of the destructor plants thus far introduced in American and Canadian cities has been found to be much greater

than in Europe. In the works thus far installed, which are for the most part of small size and have been operated only for a very limited time, the cost of operation has ranged from $1 to $1.25 per ton of refuse burned. The experience with works of this kind thus far introduced in American and Canadian cities has been a very favorable one so far as the efficient disposal of the refuse and the prevention of nuisance is concerned. The collection of the wastes is materially simplified, and the refuse delivered at the destructor works is reduced to inoffensive clinker and ashes without creating objectionable conditions in the neighborhood. No separation of the refuse is required by the householder, but all wastes — garbage, ashes and all other refuse — are deposited in the same receptacle for removal to the disposal works, and the annoyances caused by the necessity for an efficient separation of the various wastes are avoided.

The cost of disposing of municipal refuse efficiently by cremation, using the destructors of the general type herein described, would probably be considerably greater in most cases than by the methods now in use, especially in places where an income is obtained from the sale of garbage for feeding to swine; but by the use of the destructor an efficient and sanitary method of refuse disposal is provided, in place of inefficient and often highly objectionable ones.

In the operation of destructor plants in European cities it has been found that municipal refuse, even when all kinds are mixed together, has a large steam-producing value, estimated to be equivalent to from one-tenth to one-sixth that of good coal; and in many of the English works the surplus heat not required in the operation of the plant is used for the production of electric light or power for municipal purposes or for pumping water or sewage, and very material economies are secured in the operation of these plants by utilizing the surplus heat in this way. The residue from a destructor plant after combustion amounts generally to between 30 and 40 per cent. of the material burned, and consists in part of clinker and in part of fine ashes. In many places the clinker has a commercial value for use in the construction of roads and sidewalks and for other purposes.

The question of the economies derivable from the use of surplus heat in the operation of destructor plants in American cities remains to be determined by experience. It is hardly likely that in the case of destructor works of small size in American cities the surplus power can be disposed of or utilized in such a way as to secure a very considerable return. In the case of larger works it is not unlikely that a material offset to the cost of maintaining and operating the works may be secured by the use or sale of surplus power, while in some localities the clinker may be found to have a considerable value.

In General.

There is no doubt that a marked change in the present methods of disposing of municipal waste is rapidly becoming necessary in many American cities and in the larger towns, where present methods are objectionable and are rapidly becoming impracticable; and as necessity compels the introduction of more efficient methods of refuse disposal, cremation in destructor works affords an efficient and satisfactory method of rendering innocuous the large quantities of foul organic matter, including infectious material collected from dwelling houses, stores, streets, and markets of densely populated districts. From a sanitary point of view this method of refuse disposal is the best that has thus far been devised for preventing nuisance and the possible spread of infection in the disposal of such wastes.

The destructor as a means of disposing of municipal refuse has long since passed the experimental stage, and by its extensive employment city wastes are disposed of in foreign countries far more effectively and satisfactorily than in most American cities. Doubt has been expressed as to the applicability of this method in American cities, on account of possible differences in the composition of the refuse to be treated; and it is pointed out that the waste of householders in America results in the production of much larger quantities of garbage than in European cities. While this is very likely true, it is probably also true that the refuse from American cities contains greater quantities of combustible waste, — such as wood, paper, etc. — than are found in the wastes of European cities, a condition which would have a tendency to offset any excess in the amount of garbage. The actual experience with the destructor plants that have been introduced in American cities shows thus far that the efficiency of the modern cremation works or destructor in cremating municipal waste without nuisance is as great in American as in English cities. It is likely that there will be changes and improvements in the design of destructor works, and trial is being made of the efficiency of cells of various sizes, especially smaller cells operated at higher temperatures than those generally employed in the destructors thus far introduced.

The destructor works in operation in foreign cities and those thus far introduced in American cities have been built and are operated by the municipality under engineering supervision. In the design of a destructor plant and in its location there are many circumstances to be considered, most of which are engineering questions which require careful study in order that the destructor may be adapted in location and in design to the work which it will be required to do. The works should be located with reference to the area from which the refuse is to be col-

lected, its accessibility, the practicability of utilizing the surplus heat and disposing satisfactorily of the clinker and ashes, and the handling of all materials at a minimum of difficulty and cost. There are also details of the feeding and stoking of these furnaces which must be carefully considered in connection with the character of the waste to be disposed of in designing the works.

The reduction method for the disposal of garbage, as hitherto developed, has been in many cases a source of complaint on account of objectionable odors, and the method provides at best only for a portion of the wastes requiring disposal. This method, which has recently been considerably improved, may still be used for the treatment of garbage in places where an available site can be secured and where it is not deemed essential to provide, for the time being at least, a more efficient system of disposal for the remaining municipal wastes than by discharging them upon dumps. It is possible also that advantage may be taken of the present habit of keeping garbage separate from the other municipal wastes to utilize the reduction method of garbage disposal in connection with destructor works, securing the economies obtainable from the sale of grease, tankage, etc., recovered from the garbage, — a scheme which has been suggested recently in connection with the disposal of the refuse of the city of Boston. The reduction process involves commercial good management in the sale of products, — a disadvantage where such works are to be operated under municipal control. In any case, the reduction method of garbage disposal, if its use is to be continued, must be improved to such an extent that nuisance can with certainty be prevented, and past experience is likely to be a considerable handicap in its future development, especially in connection with destructor works, one of the advantages of which is that they can be located in the midst of a populous district without danger of causing a nuisance. Nevertheless the operation of a reduction works in connection with a destructor plant appears to offer an opportunity for taking full advantage of the economies of each method, utilizing the waste heat or power from the destructor for operating the reduction works, and securing at the same time the income derivable from the sale of commercial products resulting from the reduction of the garbage. While no such combination works has yet been tried, there appears to be no reason why such a works, properly designed, cannot be operated without nuisance. If a works of this kind for treating municipal refuse in large quantities shall be installed, the results will be awaited with great interest.

In view of the probability that material changes in the methods of disposing of city and town refuse are likely to become essential in the near future, it is of special importance for cities and towns to keep accurate

records of the amount and character of their municipal wastes at all seasons of the year. Information collected from the cities and towns in Massachusetts in which the collection and disposal of municipal waste is regulated by the city, shows that in a few of the larger cities careful records are kept of the weight and volume of the various materials disposed of, which show the variations in the quantity and character of the different wastes at different times during the year, the methods by which they are collected, their time of delivery, length of haul, etc. It is very important that such records be kept in all municipalities, since such information will assist greatly in selecting improved methods of disposal when changes in existing methods become essential.

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The report of the chief analyst presents in detail the work of this department for the year ended Nov. 30, 1909. The following personnel comprised the laboratory force: —

HERMANN C. LYTHGOE,	*Chief Analyst.*	HORACE F. DAVIS,	*Inspector.*
CHARLES H. HICKEY,	*First Asst. Analyst.*	DANIEL E. MCCARTHY,	*Inspector.*
LEWIS I. NURENBERG,	*Second Asst. Analyst.*	FREDERICK L. MARION,	*Inspector.*
CLARENCE E. MARSH,	*Third Asst. Analyst.*	MAURICE P. CROWE,	*Inspector.*

The number of samples examined during this period, together with a summary of work done since the passage of the law in 1882, follows: —

Food and Drug Inspection (1882–1909).

SUMMARY.	YEARS.	
	1909.	Total 1882–1909.
Number of samples of milk examined,	4,611	105,608
Number of samples above standard,	3,584	68,098
Number of samples below standard,	1,027	37,510
Number of samples of other kinds of food examined (not milk),	1,837	64,541
Number of samples of good quality,	1,504	52,670
Number of samples adulterated, as defined by the statutes,	333	11,871
Number of samples of drugs examined,	889	20,471
Number of samples of good quality,	708	13,340
Number of samples adulterated, as defined by the statutes,	181	7,131
Total examination of food and drugs,	7,337	190,620
Total samples of good quality,	5,796	134,108
Total samples not conforming to the statutes,	1,541	56,512

Section 7 of chapter 75 of the Revised Laws provides that the State Board of Health "shall annually report to the general court the number of prosecutions made under the provisions of sections sixteen to twenty-seven, inclusive, and an itemized account of the money expended in carrying out the provisions thereof;" and in accordance with this provision the following report is made.

The total number of prosecutions entered during the fiscal year ended Nov. 30, 1909, was 296. Of these, 267 resulted in conviction, 14 in acquittal; 2 were nol-prossed; and 11 were dismissed on motion of the inspector. Two other cases came to trial, but were dismissed by order of the court. There are 18 cases pending on appeal to the Superior Court.

The amount paid in fines was $5,666.74, which brings the sum total to $78,743.52.

Prosecutions.

The following table presents the statistics relative to the prosecutions which have been conducted under the food and drug acts since the beginning of work in 1883 (Revised Laws, chapter 75, sections 16 to 27) : —

Number of Complaints entered in Court.

Year.	Food and Other Articles (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines imposed.
1883, . . .	–	5	4	9	8	–[1]
1884, . . .	2	1	45	48	44	–[1]
1885,[2] . . .	50	1	68	119	103	–[1]
1886,[3] . . .	10	–	10	20	19	–[1]
1887, . . .	30	–	34	64	60	–[1]
1888, . . .	22	–	43	65	61	$2,042 00
1889, . . .	74	–	66	140	124	3,889 00
1890, . . .	78	–	24	102	96	3,919 00
1891, . . .	96	5	49	150	135	2,668 00
1892, . . .	52	12	72	136	123	3,661 70
1893, . . .	26	3	67	96	92	2,476 00
1894, . . .	14	–	76	90	77	2,625 00
1895, . . .	13	11	68	92	86	2,895 30
1896, . . .	7	–	68	75	74	2,812 20
1897, . . .	13	1	51	65	64	2,756 60
1898, . . .	10	–	54	64	62	2,060 98
1899, . . .	19	2	26	47	45	1,432 66
1900, . . .	45	5	44	94	89	1,890 70
1901, . . .	30	–	65	99	90	1,874 70
1902, . . .	25	3	48	76	74	2,617 98
1903, . . .	34	1	44	79	70	1,297 66
1904, . . .	6	6	50	62	57	1,509 00
1905, . . .	209	27	77	313	275	8,486 00
1906,[4] . . .	177	60	171	409	383	7,316 00
1907, . . .	123	63	147	333	290	6,546 00
1908, . . .	76	138	219	433	386	8,300 30
1909, . . .	72	44	180	296	267	5,666 74

[1] No record kept.
[2] To May 1, 1886.
[3] Four months only.
[4] Fourteen months, from Sept. 30, 1905.

The nature of the offences brought to the attention of the courts during the year, the names of the defendants, the places where the offences were committed, the dates of trial or indictment, and the results of the prosecutions, are set forth in the following table: —

For Sale of Milk not of Good Standard Quality.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Munroe B Chesley,	Amesbury,	11.00[1]	May 18, 1909,	Conviction.
Munroe B. Chesley,	Amesbury,	10.40[2]	May 18, 1909,	Conviction.
John Larnard,	Amesbury,	11.50	May 18, 1909,	Conviction.
George L. Averill,	Andover,	10.91[1]	Nov. 30, 1909,	Conviction.
George Dufton,	Andover,	11.20	Feb. 24, 1909,	Conviction.
Aharon Kasbaian,	Andover,	10.10[2]	Nov. 8, 1909,	Conviction.
Aharon Kasbaian,	Andover,	10.86[2]	Nov. 8, 1909,	Conviction.
Edward A. Piper,	Ashby,	8.32[1,2]	Apr. 13, 1909,	Conviction.
Wm. R. Underhill,	Ashby,	9.80[1]	Apr. 13, 1909,	Conviction.
Orrin H. Keith,	Attleborough,	11.06[2]	Nov. 14, 1909,	Conviction.
Orrin H. Keith,	Attleborough,	11.13	Nov. 14, 1909,	Conviction.
George H. Swift,	Berkley,	11.60[2]	Oct. 29, 1909,	Conviction.
Roger S. Abbott,	Beverly,	10.58[2]	July 22, 1909,	Conviction.
Charles Cox,	Beverly,	11.17[2]	Sept. 27, 1909,	Conviction.[3]
William E. Dailey,	Braintree,	9.94[2]	May 1, 1909,	Conviction.
Jacob A. Dyer,	Braintree,	9.68[1]	Apr. 10, 1909,	Conviction.
Albert L. Forbush,	Braintree,	11.22	July 15, 1909,	Conviction.
John King,	Braintree,	11.40	June 25, 1909,	Conviction.
John King,	Braintree,	11.80	June 25, 1909,	Conviction.
Ernest A. Peck,	Brockton,	10.72[2]	Oct. 21, 1909,	Conviction.
Ernest A. Peck,	Brockton.	10.72	Oct. 21, 1909,	Conviction.
Arthur E. Dutton,	Chelmsford,	11.52	Apr. 28, 1909,	Conviction.[3]
James McCormick,	Chelmsford,	10.92	Oct. 26, 1909,	Conviction.
James McCormick,	Chelmsford,	10.94[2]	Oct. 26, 1909,	Conviction.
Edward C. Wright,	Chelmsford,	10.49[2]	Apr. 28, 1909,	Dismissed.[4]
Edward C. Wright,	Chelmsford,	10.49[2]	Apr. 28, 1909,	Nol-prossed.
James Breen,	Concord,	9.54[2]	Oct. 7, 1909,	Conviction.
John A. Burgner,	Dalton,	9.45[2]	Aug. 6, 1909,	Conviction.
John A. Burgner,	Dalton,	11.87[1]	Aug. 6, 1909,	Conviction.
Jacob F. Kirchner,	Dalton,	12.00[2]	Oct. 6, 1909,	Conviction.

[1] Removal of cream alleged in complaint.
[2] Addition of water alleged in complaint.
[3] Appealed to upper court; case pending.
[4] Dismissed for want of prosecution, on motion of inspector.

For Sale of Milk not of Good Standard Quality — Continued.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Henry H. Wehry, . . .	Dalton, . .	11.16[1]	Aug. 6, 1909,	Conviction.
Wilbur Elliot, . . .	Danvers, . .	11.30	Dec. 16, 1908,	Acquittal.
Arthur Howland, . . .	Dartmouth, .	11.40[1]	Dec. 29, 1908,	Conviction.
Adolphe Bouchard, . .	Dracut, . .	11.50[2]	Sept. 1, 1909,	Conviction.
John C. Fox, . . .	Dracut, . .	8.74[2]	Dec. 30, 1908,	Conviction.
John C. Fox, . . .	Dracut, . .	9.50[2]	Dec. 30, 1908,	Conviction.
William L. Peabody, . .	Dracut, . .	11.70	Feb. 5, 1909,	Conviction.
Frank Chapman, . . .	Dunstable, . .	11.24[2]	Mar. 13, 1909,	Conviction.
Alfred Charron, . . .	Easthampton, .	9.64[1]	Feb. 23, 1909,	Conviction.
Robert Evans, . . .	Falmouth, . .	10.50	Oct. 28, 1909,	Conviction.
Olin E. Swan, . . .	Framingham, .	11.56	Apr. 21, 1909,	Conviction.
Joseph A. Butler, . . .	Gloucester, . .	11.60	Aug. 19, 1909,	Conviction.
Thomas Connelley, . .	Gloucester, . .	7.72[1 2]	Aug. 19, 1909,	Conviction.[3]
Thomas Connelley, . .	Gloucester, . .	7.72[2]	Aug. 19, 1909,	Conviction.[3]
Gloucester Dairy Company, .	Gloucester, . .	11.12[2]	Aug. 19, 1909,	Acquittal.
Isaac Knudsen, . . .	Gloucester, . .	11.34	Aug. 27, 1909,	Conviction.
North Shore Dairy Association,	Gloucester, . .	11.40	Aug. 19, 1909,	Conviction.
North Shore Dairy Association,	Gloucester, . .	11.80[2]	Aug. 19, 1909,	Conviction.[3]
North Shore Dairy Association,	Gloucester, . .	9.20[2]	Aug. 19, 1909,	Conviction.[3]
North Shore Dairy Association,	Gloucester, . .	11.00[2]	Aug. 19, 1909,	Conviction.[3]
John G. Nutton, . . .	Gloucester, . .	11.73	Sept. 15, 1909,	Dismissed.[4]
George E. Waldron, . .	Gloucester, . .	11.52[1]	Aug. 26, 1909,	Acquittal.
George E. Waldron, . .	Gloucester, . .	11.50	Aug. 26, 1909,	Acquittal.
Hubert H. Hall, . . .	Great Barrington,	10.26[2]	Sept. 11, 1909,	Conviction.
Hubert H. Hall, . . .	Great Barrington,	8.94[2]	Sept. 11, 1909,	Conviction.
Morris E. Field, . . .	Greenfield, . .	7.43[1 2]	Jan. 29, 1909,	Conviction.
Albert M. Brown, . . .	Harvard, . .	11.02	July 19, 1909,	Conviction.
Albert M. Brown, . . .	Harvard, . .	10.20[2]	July 19, 1909,	Conviction.
Chas. W. Emerson, . .	Haverhill, . .	11.37	Jan. 25, 1909,	Conviction.
Harry C. Lyons, . . .	Haverhill, . .	8.82[2]	Aug. 16, 1909,	Conviction.
Harry C. Lyons, . . .	Haverhill, . .	8.82	Aug. 16, 1909,	Conviction.
Daniel L. Reynolds, . .	Haverhill, . .	11.12[2]	Nov. 1, 1909,	Conviction.
Daniel L. Reynolds, . .	Haverhill, . .	11.12	Nov. 1, 1909,	Conviction.
George Kafalas, . . .	Ipswich, . .	11.52	Dec. 26, 1908,	Conviction.
Nicklos Kafalas, . . .	Ipswich, . .	11.20[2]	Dec. 26, 1908,	Conviction.

[1] Removal of cream alleged in complaint.
[2] Addition of water alleged in complaint.
[3] Appealed to upper court; case pending.
[4] Dismissed for want of prosecution, on motion of inspector.

For Sale of Milk not of Good Standard Quality — Continued.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
John G. McPhee,	Ipswich,	9.82 [1]	Dec. 26, 1908,	Conviction.
John G. McPhee,	Ipswich,	9.70 [1]	Dec. 26, 1908,	Conviction.
Jesse H. Whipple,	Ipswich,	10.23 [1]	Dec. 26, 1908,	Conviction.
Jesse H. Whipple,	Ipswich,	9.82 [1]	Dec. 26, 1908,	Conviction.
Martial G. Gagne,	Lawrence,	11.40	Dec. 8, 1908,	Conviction. [2]
Isaiah R. Kimball,	Lawrence,	11.92	Aug. 18, 1909,	Conviction.
Jabez R. Summersgill,	Lawrence,	8.27 [1 3]	Feb. 24, 1909,	Conviction.
George E. Blake,	Lenox,	11.80 [3]	Oct. 23, 1909,	Conviction.
Chas. W. Harris,	Leominster,	10.66 [1]	Oct. 27, 1909,	Conviction. [2]
John H. Hargrove,	Lexington,	11.68 [3]	July 23, 1909,	Conviction.
Isaac B. Cook,	Lincoln,	11.56 [1]	July 23, 1909,	Conviction.
George Yapp,	Littleton,	11.02	May 28, 1909,	Conviction.
Arthur G. Boynton,	Lowell,	10.93	Jan. 6, 1909,	Dismissed. [4]
Leslie G. Hill,	Lowell,	11.72	Sept. 1, 1909,	Conviction. [2]
James Brown,	Lunenburg,	11.20	Apr. 13, 1909,	Acquittal.
Stephen Benea,	Lynn,	11.57	Oct. 25, 1909,	Conviction.
Joseph Levett,	Lynn,	10.80 [3]	Oct. 25, 1909,	Conviction.
Geo. W. Mansfield,	Lynn,	8.42 [1 3]	Jan. 9, 1909,	Acquittal.
Charles C. Nunn,	Lynn,	11.86 [3]	Oct. 25, 1909,	Conviction.
William McNiff,	Marlborough,	10.60 [1]	Oct. 2, 1909,	Conviction.
William McNiff,	Marlborough,	10.80	Oct. 2, 1909,	Conviction.
Chas. H. Peloquin,	Marlborough,	11.70	Apr. 10, 1909,	Conviction.
Adelard J. Poudrier,	Marlborough,	11.66	Apr. 10, 1909,	Conviction.
Frank J. Rooney,	Marlborough,	12.08 [1]	Oct. 2, 1909,	Conviction.
Frank J. Rooney,	Marlborough,	12.02	Oct. 2, 1909,	Conviction.
William Fleming,	Medford,	11.94	July 27, 1909,	Conviction.
William Fleming,	Medford,	11.44 [3]	July 27, 1909,	Conviction.
Ernest Harnish,	Methuen,	11.32	Dec. 8, 1908,	Conviction.
Otto Minzner,	Methuen,	11.65	Mar. 5, 1909,	Conviction. [2]
Patrick J. O'Leary,	Methuen,	11.37	July 13, 1909,	Conviction.
Edward P. Reynolds,	Methuen,	10.34 [1]	Dec. 8, 1908,	Conviction.
Edward P. Reynolds,	Methuen,	10.34 [1]	Dec. 8, 1908,	Conviction.
Varnum B. Richardson,	Methuen,	10.94	Feb. 27, 1909,	Conviction.
Leonard Hammer,	Monterey,	11.00 [1]	Aug. 31, 1909,	Conviction.
Bartholomew J. Carroll,	Natick,	10.91 [1]	Oct. 23, 1909,	Conviction.

[1] Addition of water alleged in complaint.
[2] Appealed to upper court; case pending.
[3] Removal of cream alleged in complaint.
[4] Dismissed for want of prosecution, on motion of inspector.

For Sale of Milk not of Good Standard Quality — Continued.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Wm. P. Crowley,	Needham,	10.14[1]	Sept. 30, 1909,	Conviction.
Wm. P. Crowley,	Needham,	10.44	Sept. 30, 1909,	Conviction.
John C. Moynihan,	Newburyport,	10.66[1]	May 12, 1909,	Conviction.
John C. Moynihan,	Newburyport,	10.66	May 12, 1909,	Conviction.
John A. Johnson,	North Adams,	10.88	Oct. 16, 1909,	Conviction.
Willard O. Putnam,	North Andover,	9.34[1]	Aug. 18, 1909,	Conviction
Willard O. Putnam,	North Andover,	11.24[2]	Aug. 18, 1909,	Conviction.
Willard O. Putnam,	North Andover,	11.24[2]	Aug. 18, 1909,	Conviction.
Frank O. Rea,	North Andover,	10.88	Mar. 12, 1909,	Conviction.
George A. Rea,	North Andover,	11.66	Mar. 12, 1909,	Acquittal.
Anthony Rogers,	North Andover,	10.48[1]	Nov. 24, 1909,	Conviction.
Anthony Rogers,	North Andover,	10.53[1]	Nov. 24, 1909,	Conviction.
Herbert L. Kimball,	Northborough,	11.57	Apr. 30, 1909,	Conviction.
Willis E. Wheeler,	Northborough,	11.42[1]	Aug. 30, 1909,	Conviction.
Frank W. Chase,	Oak Bluffs,	11.53	Sept. 14, 1909,	Conviction.[3]
Daniel E. Cummings,	Peabody,	8.24[1]	June 14, 1909,	Conviction.
Frank T. Moore,	Peabody,	10.80	July 12, 1909,	Conviction.[3]
Frank T. Moore,	Peabody,	11.04[1]	July 12, 1909,	Conviction.[3]
John P. Dowling,	Pittsfield,	12.00[1]	Feb. 25, 1909,	Conviction.
John P. Dowling,	Pittsfield,	12.00[1]	Feb. 25, 1909,	Conviction.
Martin E. Egan,	Pittsfield,	10.52[1]	Oct. 22, 1909,	Conviction.
Joseph Loehr,	Pittsfield,	10.90[1]	Aug. 6, 1909,	Conviction.
William S. Noble,	Pittsfield,	9.52[4]	Oct. 6, 1909,	Conviction.
James E. Torrey,	Pittsfield,	11.80	Feb. 25, 1909,	Conviction.
James E. Torrey,	Pittsfield,	11.80[1]	Feb. 25, 1909,	Conviction.
Mariano D. Arude,	Raynham,	12.24[1]	Oct. 29, 1909,	Conviction.
John Parker,	Raynham,	11.06[1]	Sept. 28, 1909,	Conviction.
Wm. D. Emerson,	Reading,	10.23[1]	Dec. 5, 1908,	Conviction.
George P. Becket,	Revere,	11.20[1]	July 10, 1909,	Conviction.
Joseph Fortunate,	Revere,	11.47	Jan. 8, 1909,	Conviction.
Harry Medlyn,	Richmond,	10.32[1]	Oct. 6, 1909,	Conviction.
John Bedard,	Rochester,	11.82[1]	Dec. 28, 1908,	Conviction.
John Bedard,	Rochester,	11.86	Dec. 28, 1908,	Conviction.
William Horgan,	Salem,	11.36[1]	Dec. 29, 1908,	Conviction.
Joseph L'Heureux,	Spencer,	11.82	Nov. 15, 1909,	Acquittal.

[1] Addition of water alleged in complaint.
[2] Removal of cream alleged in complaint.
[3] Appealed to upper court; case pending.
[4] Skimmed milk; cans not marked.

For Sale of Milk not of Good Standard Quality — Concluded.

Name.	Place.	Percentage of Total Solids.	Date.	Result.
Wm. H. Wakefield, . .	Spencer, . .	11.10[1]	Nov. 15, 1909,	Conviction.[2]
Henry M. Wade, . . .	Stockbridge, .	12.00[1]	Oct. 23, 1909,	Conviction.
Wm. A. Kimball, . . .	Stoughton, . .	11.70[3]	Nov. 26, 1909,	Conviction.
Charles R. Luther, . .	Sutton, . .	11.74[1]	Aug. 26, 1909,	Conviction.
Edgar A. Sargent, . . .	Sutton, . .	10.46[1]	Aug. 26, 1909,	Conviction.
Wm. E. Briggs, . . .	Taunton, . .	11.20[1]	Oct. 29, 1909,	Conviction.
George H. Gould, . . .	Taunton, . .	10.71[1]	May 14, 1909,	Conviction.
David S. Clarke, . . .	Topsfield, . .	10.80	Aug. 18, 1909,	Conviction.
David S. Clarke, . . .	Topsfield, . .	10.64[3]	Aug. 18, 1909,	Conviction.
Alex. Francis, . . .	Truro, . .	11.44[1]	Aug. 28, 1909,	Conviction.
Alex. Francis, . . .	Truro, . .	11.44	Aug. 28, 1909,	Conviction.
John T. Ahlman, . . .	Waltham, . .	11.30[3]	Dec. 24, 1908,	Conviction.
Frank Loehr, . . .	Washington, .	11.62	Aug. 6, 1909,	Conviction.
Frank Loehr, . . .	Washington, .	10.32[1]	Oct. 6, 1909,	Conviction.
Duane H. Waller, . . .	Westford, . .	11.60	Jan. 23, 1909,	Conviction.
Samuel Mills, . . .	Westminster, .	11.14	May 17, 1909,	Conviction.
Loues Reynolds, . . .	Westminster, .	11.46	May 29, 1909,	Conviction.
Dennis Cohan, . . .	Weymouth, .	10.90[1]	Nov. 30, 1909,	Dismissed.[4]
Dennis Cohan, . . .	Weymouth, .	12.57	Nov. 30, 1909,	Dismissed.[4]
Daniel Riley, . . .	Weymouth, .	10.16[1]	Nov. 30, 1909,	Conviction.[2]
Daniel Riley, . . .	Weymouth, .	12.20	Nov. 30, 1909,	Dismissed.[4]
Harry Mack, . . .	Winchendon, .	11.84	July 29, 1909,	Conviction.
Elliot M. Whitcomb, . .	Winchendon, .	11.32[3]	July 8, 1909,	Acquittal.
Elliot M. Whitcomb, . .	Winchendon, .	11.32	July 16, 1909,	Conviction.
Almon E. Richardson, . .	Winchester, .	10.90	Oct. 16, 1909,	Conviction.
Anthony C. Richardson, .	Winchester, .	10.90	Oct. 16, 1909,	Conviction.
Robert Hargrove, . . .	Woburn, . .	12.25[1]	Aug. 28, 1909,	Conviction.
Albert E. Kenneson, . .	Woburn, . .	12.14[3]	Dec. 19, 1908,	Conviction.
Albert E. Kenneson, . .	Woburn, . .	12.26[3]	Dec. 19, 1908,	Conviction.
John A. Porter, . . .	Woburn, . .	11.84	Sept. 4, 1909,	Conviction.
John A. Porter, . . .	Woburn, . .	11.90[3]	Sept. 4, 1909,	Conviction.
Wm. J. Whalen, . . .	Woburn, . .	11.74	Dec. 10, 1908,	Conviction.
Michael S. Tavitian, . .	Plaistow, N. H., .	11.06	Aug. 16, 1909,	Conviction.
Michael S. Tavitian, . .	Plaistow, N. H., .	8.82[1]	Aug. 16, 1909,	Conviction.

[1] Addition of water alleged in complaint.
[2] Appealed to upper court; case pending.
[3] Removal of cream alleged in complaint.
[4] Dismissed for want of prosecution, on motion of inspector.

For sale of Milk containing Added Foreign Matter.

Name.	Place.	Adulterant.	Date.	Result.
Albert H. Friend, .	Gloucester, .	Coloring matter, .	Aug. 19, 1909,	Conviction.[1]
Albert H. Friend, .	Gloucester, .	Coloring matter, .	Aug. 19, 1909,	Conviction.[1]

For Sale of Adulterated Cream.

George Dee, . . .	Lynn, . .	Calcium sucrate, .	Dec. 5, 1908,	Conviction.
Richard J. Borden, .	Quincy, . .	Calcium sucrate, .	Dec. 2, 1908,	Acquittal.
John W. Davies, .	Reading, . .	Calcium sucrate, .	Dec. 5, 1908,	Conviction.
Daniel A. Neylon, .	Springfield, .	Sugar and calcium sucrate.	Feb. 19, 1909,	Conviction.
James P. Murphy, .	Watertown, .	Calcium sucrate, .	Dec. 8, 1908,	Nol-prossed.
David E. Powers, agent,	Watertown, .	Calcium sucrate, .	Dec. 17, 1908,	Acquittal.

[1] Appealed to upper court; case pending.

For Sale of Unmarked Renovated Butter.

Name.	Place.	Date.	Result.
Oscar Drew, ...	Boston, . . .	Jan. 18, 1909,	Conviction.
Albert H. Daly, ...	Springfield, . .	May 19, 1909,	Conviction.

For Sale of Oleomargarine as Butter.

Wm. E. Megett, ...	Worcester, . .	July 28, 1909,	Conviction.

For Sale of Adulterated Foods other than Milk and Milk Products.

Hamburg Steak.

Name.	Place.	Adulterant.	Date.	Result.
Archibald T. Blair, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
John J. Brosnahan, .	Boston, . .	Sulphurous acid, .	Jan. 28, 1909,	Acquittal.
John F. Coleman, .	Boston, . .	Sulphurous acid, .	Feb. 5, 1909,	Conviction.
Geo. W. Gilbert, .	Boston, . .	Sulphurous acid, .	Feb. 11, 1909,	Conviction.
Morris Goldman, .	Boston, . .	Sulphurous acid, .	Mar. 19, 1909,	Conviction.
Daniel R. Grewer, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Thos. F. Grinham, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Wm. D. Halward, .	Boston, . .	Sulphurous acid, .	Mar. 9, 1909,	Conviction.
Herman H. Hescamp, .	Boston, . .	Sulphurous acid, .	Mar. 24, 1909,	Conviction.
Herman H. Hescamp, .	Boston, . .	Sulphurous acid, .	Mar. 24, 1909,	Conviction.

For Sale of Adulterated Foods Other than Milk and Milk Products — Continued.

HAMBURG STEAK — Concluded.

NAME.	Place.	Adulterant.	Date.	Result.
Israel Mostowitz, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Joseph Pellman, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Elbridge A. Pickard, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Simon Piletzky, . .	Boston, . .	Sulphurous acid, .	Dec. 3, 1908,	Conviction.
David Reid, . .	Boston, . .	Sulphurous acid, .	Mar. 19, 1909,	Conviction.
Geo. W. Scott, . .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Bernard I. Siegel, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Fenwick Steeves, .	Boston, . .	Sulphurous acid, .	Feb. 23, 1909,	Conviction.
Benj. F. Thomas, .	Boston, . .	Sodium sulphide, .	Jan. 27, 1909,	Conviction.
Albert J. Barney, .	New Bedford, .	Sulphurous acid, .	Jan. 26, 1909,	Conviction.

SAUSAGE.

Herbert B. Hathaway,	Arlington, .	Sulphurous acid, .	Dec. 11, 1908,	Conviction.
Herbert B. Hathaway,	Arlington, .	Sulphurous acid, .	Dec. 11, 1908,	Conviction.
Angelo Acerra, . .	Boston, . .	Sulphurous acid, .	Mar. 19, 1909,	Conviction.
Mederic Diegeant, .	Boston, . .	Sulphurous acid, .	Apr. 23, 1909,	Conviction.
Cro. Giordano, . .	Boston, . .	Sulphurous acid, .	Mar. 19, 1909,	Conviction.
Charles H. Thompson, .	Worcester, .	Sulphurous acid, .	May 7, 1909,	Dismissed.[1]

BEEF SAUSAGE.

Herbert B. Hathaway,	Arlington, .	Sulphurous acid, .	Dec. 11, 1908,	Conviction.
Herbert B. Hathaway,	Arlington, .	Sulphurous acid, .	Dec. 11, 1908,	Conviction.

TOMATO SAUSAGE.

Philip W. Rounsewell, .	Boston, . .	Sulphurous acid, .	Jan. 22, 1909,	Conviction.
Philip W. Rounsewell, .	Boston, . .	Sulphurous acid, .	Jan. 22, 1909,	Conviction.
Carl Hineburg, . .	Boston, . .	Sulphurous acid, .	Jan. 27, 1909,	Dismissed.[2]
John R. Harris, . .	Lawrence, .	Sulphurous acid, .	Jan. 29, 1909,	Conviction.
Wm. Kingsley, . .	Lawrence, .	Sulphurous acid, .	Jan. 15, 1909,	Conviction.
Herbert Leed, . .	Lawrence, .	Sulphurous acid, .	June 15, 1909,	Conviction.
James Smith, . .	Lowell, . .	Sulphurous acid, .	Jan. 23, 1909,	Conviction.
Valentine Dooley, .	Salem, . .	Sulphurous acid, .	Mar. 11, 1909,	Conviction.
Herman Isenberg, .	Springfield, .	Sulphurous acid, .	May 26, 1909,	Conviction.

SHRIMP.

Herman Isenberg, .	Springfield, .	Boron compound, .	May 26, 1909,	Conviction.

[1] Dismissed by order of the court. [2] Dismissed for want of prosecution, on motion of inspector.

For Sale of Adulterated Foods Other than Milk and Milk Products — Continued.

TOMATO CATSUP.

NAME.	Place.	Adulterant.	Date.	Result.
James H. Carr, . .	Lowell, . .	Benzoic acid, .	Jan. 23, 1909,	Conviction.

CIDER VINEGAR.

NAME.	Place.	Adulterant.	Date.	Result.
Joseph Laurin, . .	Lowell, . .	Not pure cider vinegar.	June 14, 1909,	Conviction.
Wm. H. Wood, . .	New Bedford, .	Not pure cider vinegar; colored.	Jan. 26, 1909,	Conviction.
Wm. W. Babcock, .	Springfield, .	Not pure cider vinegar.	May 26, 1909,	Conviction.
John Bolan, . .	Springfield, .	Not pure cider vinegar.	May 26, 1909,	Conviction.
Wm. H. Cleary, . .	Springfield, .	Not pure cider vinegar.	May 19, 1909,	Conviction.
Stephen J. Collins, .	Springfield, .	Not pure cider vinegar.	May 26, 1909,	Conviction.
Harriman J. Haring, .	Springfield, .	Not pure cider vinegar.	May 20, 1909,	Conviction.
Clarence D. Robinson, .	Springfield, .	Not pure cider vinegar.	May 26, 1909,	Conviction.
Wm. O. Sheldon, .	Springfield, .	Not pure cider vinegar; contains alcohol.	May 22, 1909,	Conviction.
Sylvester L. Traver, .	Springfield, .	Not pure cider vinegar.	May 26, 1909,	Conviction.
Alexander Pezzini, .	West Springfield,	Colored, . .	May 19, 1909,	Conviction.
Walker Armington, Jr.,	Worcester, .	Not pure cider vinegar.	Apr. 29, 1909,	Conviction.
Michael E. McCabe, .	Worcester, .	Not pure cider vinegar.	May 7, 1909,	Dismissed.[1]
Ulderic V. Vigeant, .	Worcester, .	Not pure cider vinegar.	Apr. 29, 1909,	Conviction.
Geo. H. Williamson, .	Worcester, .	Not pure cider vinegar.	May 6, 1909,	Acquittal.

SPIRIT VINEGAR.

NAME.	Place.	Adulterant.	Date.	Result.
Frank A. Clark, . .	New Bedford, .	Acidity below legal standard.	Jan. 26, 1909,	Conviction.
Edward S. Hanks, .	West Springfield,	Artificially colored,	May 26, 1909,	Conviction.
Max Israel, . .	Worcester, .	Acidity below legal standard.	Apr. 29, 1909,	Conviction.

JAMS AND JELLIES.

NAME.	Place.	Adulterant.	Date.	Result.
Frank Bott, . .	Boston, . .	Salicylic acid, .	Apr. 13, 1909,	Conviction.

MAPLE SUGAR.

NAME.	Place.	Adulterant.	Date.	Result.
Spiros Kanzias, . .	Boston, . .	Cane sugar, . .	Mar. 29, 1909,	Conviction.
Charles Maspero, .	Boston, . .	Cane sugar, . .	Apr. 5, 1909,	Conviction.
Louis Sasserno, . .	Boston, . .	Cane sugar, . .	Apr. 21, 1909,	Conviction.
James Paganis, . .	Ipswich, . .	Cane sugar, . .	Mar. 29, 1909,	Conviction.
Joseph Pecone, . .	Quincy, . .	Cane sugar, . .	Apr. 17, 1909,	Conviction.
Geo. N. Pilalas, . .	Springfield, .	Cane sugar, . .	May 26, 1909,	Conviction.

[1] Dismissed by order of the court.

For Sale of Adulterated Foods Other than Milk and Milk Products — Concluded.

CIDER.

NAME.	Place.	Adulterant.	Date.	Result.
Oscar Drew,	Boston,	Benzoic acid,	Jan. 18, 1909,	Conviction.
Cornelius Keefe,	Boston,	Benzoic acid,	Apr. 15, 1909,	Conviction.
Felix Russo,	Boston,	Benzoic acid,	Mar. 26, 1909,	Conviction.
Geo. L. Sharfner,	North Andover,	Sulphurous acid,	Aug. 6, 1909,	Conviction.
Edward C. Hall,	Watertown,	Benzoic acid,	Feb. 10, 1909,	Conviction.
George Tomassetti,	Watertown,	Benzoic acid,	Feb. 10, 1909,	Conviction.

For Sale of Unstamped Veal.

NAME.	Place.	Date.	Result.
Wm. S. McCarthy,	Boston,	Apr. 21, 1909,	Conviction.
Joe Keller,	Lowell,	Apr. 26, 1909,	Conviction.

For Sale of Adulterated Drugs.

ALCOHOL.

NAME.	Place.	Adulterant.	Date.	Result.
Lawrence Cordella,	Haverhill,	Water,	Sept. 27, 1909,	Conviction.

OLIVE OIL.

Michael H. Ajamian,	Boston,	Cotton-seed oil,	Mar. 12, 1909,	Dismissed.[1]
Antonio Cardinali,	Boston,	Cotton-seed oil,	June 4, 1909,	Conviction.
Antonio Cardinali,	Boston,	Cotton-seed oil,	June 4, 1909,	Conviction.
Antonio Cardinali,	Boston,	Cotton-seed oil,	June 4, 1909,	Conviction.
Alfonso Guido,	Boston,	Cotton-seed oil,	Mar. 19, 1909,	Conviction
Michael Kotrosos,	Boston,	Cotton-seed oil,	Mar. 24, 1909,	Conviction.
Constantino Spiropoulos.	Boston,	Cotton-seed oil,	May 28, 1909,	Conviction.
Constantino Spiropoulos.	Boston,	Cotton-seed oil,	May 28, 1909,	Conviction.
Constantino Spiropoulos.	Boston,	Cotton-seed oil,	May 28, 1909,	Conviction.
William Canelos,	Ipswich,	Cotton-seed oil,	Mar. 29, 1909,	Conviction.
Nicklis Kintzios,	Ipswich,	Cotton-seed oil,	Mar. 29, 1909,	Conviction.
Michael Tristany,	Lee,	Cotton-seed oil,	Sept. 3, 1909,	Conviction.
Peter Patropoulos,	Malden,	Cotton-seed oil,	May 13, 1909,	Conviction.
Joseph Russo,	Malden,	Cotton-seed oil,	May 13, 1909,	Conviction,

[1] Dismissed for want of prosecution, on motion of inspector.

For Sale of Adulterated Drugs — Continued.

Olive Oil — Concluded.

Name.	Place.	Adulterant.	Date.	Result.
Michael Boccuzzo,	Newburyport,	Cotton-seed oil,	Mar. 29, 1909,	Conviction.
Mamad Effendi,	Peabody,	Cotton-seed oil,	May 1, 1909,	Conviction.
Peter Kalelis,	Peabody,	Cotton-seed oil,	May 1, 1909,	Conviction.
James Liacos,	Peabody,	Cotton-seed oil,	May 1, 1909,	Conviction.
Louis Sgondas,	Peabody,	Cotton-seed oil,	May 1, 1909,	Conviction.
Emanuel J. Sophos,	Peabody,	Cotton-seed oil,	May 1, 1909,	Conviction.
Eugene B. Carpenter,	Somerville,	Cotton-seed oil,	June 28, 1909,	Conviction.
Joseph Kohn,	Salem,	Cotton-seed oil,	Mar. 11, 1909,	Conviction.

Spirit of Anise.

Name.	Place.	Adulterant.	Date.	Result.
Julius Shubert,	Boston,	Deficiency in strength.	Nov. 16, 1909,	Conviction.
Edward H. Howard,	Taunton,	Deficiency in strength.	Oct. 29, 1909,	Conviction.

Spirit of Camphor.

Name.	Place.	Adulterant.	Date.	Result.
Fred W. Putney,	Boston,	Deficiency in strength.	Oct. 6, 1909,	Conviction.
Emery M. Willard,	Boston,	Deficiency in strength.	Nov. 23, 1909,	Conviction.

Spirit of Peppermint.

Name.	Place.	Adulterant.	Date.	Result.
Curtis W. Lund,	Hyde Park,	Deficiency in strength.	Nov. 27, 1909,	Conviction.
Edward H. Howard,	Taunton,	Deficiency in strength.	Oct. 29, 1909,	Conviction.

Tincture of Iodine.

Name.	Place.	Adulterant.	Date.	Result.
Felice Lauricella,	Boston,	Low in iodine,	Dec. 4, 1908,	Conviction.
Frank I. Pierson,	Leominster,	Low in iodine,	Nov. 3, 1909,	Conviction.
Herbert J. Turcotte,	Lowell,	Low in iodine,	Nov. 4, 1909,	Conviction.
Geo. L. Dauphinee,	Millis,	Low in iodine,	Aug. 14, 1909,	Conviction.
Geo. L. Dauphinee,	Millis,	Low in iodine,	Aug. 14, 1909,	Conviction.
Frank R. Pease,	New Bedford,	Low in iodine,	Jan. 26, 1909,	Conviction.
Charles F. Lane,	Tisbury,	Low in iodine,	Sept. 14, 1909,	Conviction.

Mercurial Ointment.

Name.	Place.	Adulterant.	Date.	Result.
Paul C. Klein,	Boston,	Deficiency in strength.	July 3, 1909,	Conviction.
John H. C. Pratt,	Everett,	Deficiency in strength.	May 13, 1909,	Conviction.
Fred A. Spencer,	Everett,	Deficiency in strength.	May 13, 1909,	Acquittal.
Charles L. Davis,	Newburyport,	Deficiency in strength.	May 8, 1909,	Conviction.

For Sale of Adulterated Drugs — Concluded.

Mercurial Ointment — Concluded.

Name.	Place.	Adulterant.	Date.	Result.
Daniel P. Grosvenor, .	Peabody, . .	Deficiency in strength.	May 1, 1909,	Conviction.
Arthur J. Millea, .	Peabody, . .	Deficiency in strength.	May 1, 1909,	Dismissed.[1]
Henry J. Pushard, .	Peabody, . .	Deficiency in strength.	May 1, 1909,	Dismissed.[1]
Thomas Ryan, . .	Peabody, . .	Deficiency in strength.	May 1, 1909,	Dismissed.[1]

[1] Dismissed for want of prosecution, on motion of inspector.

Of the cases reported as pending in the last preceding report, 7 for the sale of adulterated milk resulted in conviction and fine; of 7 for the sale of adulterated foods other than milk, 6 cases were for the sale of adulterated Hamburg steak; of these, 3 resulted in acquittal, 1 was nol-prossed and 2 resulted in conviction, a fine having been imposed in one case; of 8 cases for the sale of adulterated drugs, 6 resulted in conviction and fine and 2 were nol-prossed.

Two cases for the sale of adulterated milk, pending in 1907, have come to trial during the past year, each resulting in conviction and fine.

The amount paid in fines was $5,666.74, as follows: —

Milk and milk products, ...	$3,483 52
Foods other than above, ...	1,241 18
Drugs, ...	942 04
	$5,666 74

The total number of samples of food, drugs and liquors examined during the year was as follows: —

Milk, ...	3,584
Food, ...	1,837
Drugs, ...	889
Liquors, ...	200
Total, ...	6,510

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1909.

Appropriation, ...	$14,500 00
Salaries of analysts, ...	5,800 00
Salaries of inspectors, ...	5,025 55
Travelling expenses and purchase of samples, ...	2,813 43

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1909 — Concluded.

Apparatus and chemicals,	$299 26
Printing,	91 77
Services, cleaning laboratory,	104 00
Express, telephone and telegraph messages,	12 47
Sundry laboratory supplies,	86 56
Books, binding and stationery,	40 60
Extra services,	98 67
Advertising,	58 89
Miscellaneous,	93
Total,	$14,432 13

REPORT OF THE ANALYST.

By Hermann C. Lythgoe.

REPORT OF THE ANALYST.

By Hermann C. Lythgoe.

Dr. Mark W. Richardson, *Secretary of the Massachusetts State Board of Health.*

Dear Sir: — I herewith submit my report on the analysis of food and drugs for the year ending Nov. 30, 1909.

Milk and Milk Products.

Four thousand six hundred and eleven samples of milk were examined during the year, of which 3,584 conformed to the statute requirements. The usual statistics of milk are as follows: —

Milk from Cities.

Cities.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with Orange Dye.	Number of Samples containing Added Water.
Beverly, . . .	35	5	40	10.58	–	–	3
Brockton, . . .	45	7	52	10.72	–	–	1
Cambridge, . .	26	4	30	11.59	–	–	–
Chelsea, . . .	23	10	33	9.54	–	–	1
Chicopee, . . .	30	1	31	11.86	–	–	–
Everett, . . .	11	–	11	12.36	–	–	–
Fall River, . . .	26	5	31	11.40	–	–	–
Fitchburg, . . .	78	17	95	8.32	2	–	1
Gloucester, . . .	63	26	89	7.72	–	1	8
Haverhill, . . .	103	55	158	8.72	–	–	10
Holyoke, . . .	64	5	69	9.64	1	–	–
Lawrence, . . .	84	39	123	8.27	6	–	2
Lowell, . . .	113	33	146	8.74	2	–	5
Lynn, ...	69	14	83	8.28	1	–	1
Malden, . . .	34	12	46	11.30	–	–	–

Milk from Cities — Concluded.

Cities.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Samples colored with Orange Dye.	Number of Samples containing Added Water.
Marlborough, . .	49	12	61	9.16	2	–	3
Medford, . . .	52	16	68	11.40	–	–	–
Melrose, . . .	34	2	36	12.46	–	–	–
New Bedford, . .	44	10	54	10.23	1	–	1
Newburyport, . .	57	7	64	10.66	–	–	1
Newton, . . .	31	9	40	8.96	–	–	5
North Adams, . .	75	6	81	10.88	–	–	–
Northampton, . .	14	2	16	11.76	–	–	–
Pittsfield, . . .	130	41	171	9.23	4	–	17
Quincy, . . .	60	9	69	9.94	–	–	1
Salem, . . .	100	9	109	11.48	–	–	–
Somerville, . . .	71	38	109	10.44	–	–	2
Springfield, . .	90	3	93	11.85	–	–	–
Taunton, . . .	72	8	80	9.56	3	–	5
Waltham, . . .	42	28	70	8.70	2	–	–
Woburn, . . .	30	22	52	10.98	–	–	2
Worcester, . . .	15	–	15	12.24	–	–	–
Totals, . . .	1,770	455	2,225	8.27	24	1	69

Milk from Towns.

Towns.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Samples containing Added Water.
Abington, ...	7	–	7	12.34	–	–
Adams, ...	54	8	62	11.34	–	–
Acushnet, ...	5	5	10	11.10	–	1
Amesbury, ...	20	9	29	10.13	–	4
Andover, ...	8	4	12	10.91	–	–
Arlington, ...	40	2	42	11.66	–	–
Athol, ...	15	1	16	9.80	1	–
Attleborough, ...	45	2	47	11.06	–	2
Ayer, ...	8	–	8	12.32	–	–
Braintree, ...	59	15	74	9.68	2	3
Brookline, ...	15	1	16	12.00	–	–

Milk from Towns — Continued.

Towns.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Samples containing Added Water.
Burlington,	3	4	7	11.73	–	–
Carlisle,	6	–	6	12.30	–	–
Chelmsford,	13	2	15	11.60	–	–
Clinton,	3	4	7	11.70	–	–
Concord,	9	6	15	11.66	–	–
Dalton,	15	–	15	12.18	–	–
Danvers,	12	3	15	11.68	–	–
Dedham,	9	–	9	12.40	–	–
Easton,	12	–	12	12.32	–	–
Falmouth,	4	4	8	10.50	–	1
Framingham,	36	3	39	11.56	–	–
Gardner,	13	2	15	9.50	–	1
Great Barrington,	41	16	57	8.66	–	6
Greenfield,	10	1	11	7.43	2	1
Harvard,	1	6	7	10.20	–	–
Hingham,	9	1	10	11.80	–	–
Hudson,	7	4	11	11.80	–	–
Hull,	3	6	9	12.00	–	–
Hyde Park,	48	9	57	11.00	–	1
Ipswich,	43	7	50	9.70	–	1
Lanesborough,	4	–	4	12.39	–	–
Lee,	3	–	3	12.80	–	–
Lenox,	9	5	14	12.90	–	1
Lexington,	10	3	13	11.44	–	–
Lynnfield,	1	4	5	11.76	–	–
Mansfield,	4	–	4	13.00	–	–
Marblehead,	18	5	23	11.36	–	–
Methuen,	25	2	27	9.88	2	–
Milford,	62	8	70	10.40	–	2
Millis,	19	2	21	12.00	–	–
Milton,	4	–	4	13.00	–	–
Nantucket,	12	3	15	11.90	–	–
Natick,	37	9	46	10.91	–	8
Needham,	4	9	13	11.20	–	–
North Andover,	5	4	9	9.40	1	2
North Attleborough,	26	3	29	10.81	1	–
North Reading,	–	2	2	11.08	–	–

Milk from Towns — Concluded.

Towns.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Skimmed Samples.	Number of Samples containing Added Water.
Norwood, ...	6	6	12	11.28	–	–
Oak Bluffs, ...	13	4	17	11.53	–	–
Palmer, ...	11	1	12	12.12	–	–
Peabody, ...	34	1	35	10.80	–	1
Plymouth, ...	21	4	25	9.86	1	–
Provincetown, . . .	15	8	23	9.22	–	3
Reading, ...	41	6	47	9.07	3	–
Revere, ...	14	7	21	11.47	–	1
Richmond, ...	6	3	9	10.32	–	2
Rockland, ...	27	–	27	10.37	1	–
Rockport, ...	21	2	23	10.46	–	–
Saugus, ...	16	5	21	11.36	–	–
Spencer, ...	27	5	32	11.10	–	1
Stoneham, ...	21	2	23	11.29	–	–
Stoughton, ...	15	1	16	11.70	–	–
Swampscott, . . .	14	–	14	12.46	–	–
Templeton, ...	11	2	13	9.70	1	–
Tisbury, ...	8	3	11	11.50	–	–
Wakefield, ...	21	8	29	11.38	–	–
Ware, ...	21	9	30	11.62	–	–
Warren, ...	20	3	23	11.84	–	–
Watertown, ...	13	1	14	11.97	–	–
Wellesley, ...	5	1	6	12.00	–	–
West Springfield, . . .	8	–	8	12.44	–	–
Westborough, . . .	14	1	15	10.70	–	–
Westfield, ...	22	2	24	11.20	–	–
Westford, ...	4	1	5	11.60	–	–
Westminster, . . .	6	4	10	10.60	–	–
Westwood, ...	6	–	6	12.85	–	–
Weymouth, ...	24	4	28	10.10	–	2
Whitman, ...	14	–	14	12.50	–	–
Williamstown, . . .	12	–	12	9.64	2	–
Wilmington, ...	5	1	6	11.90	–	–
Winchendon, . . .	26	7	33	9.88	1	–
Winchester, ...	16	11	27	10.62	–	1
Winthrop, ...	30	–	30	12.34	–	–
Totals, ...	1,404	297	1,701	7.43	18	45

Milk from Suspected Producers.

Locality.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Samples containing Added Water.
Andover,	–	16	16	10.10	16
Bedford,	27	26	53	10.90	–
Berkley,	16	–	16	13.09	–
Billerica,	7	7	14	10.90	–
Braintree,	15	3	18	11.66	–
Burlington,	8	1	9	12.00	–
Chelmsford,	10	22	32	10.30	9
Concord,	16	16	32	9.54	2
Danvers,	9	6	15	11.84	–
Dedham,	11	8	19	11.60	–
Dracut,	29	2	31	11.76	–
Dunstable,	2	3	5	11.24	3
Fall River,	2	4	6	10.94	–
Gloucester,	2	4	6	11.22	–
Harvard,	2	3	5	10.20	1
Haverhill,	14	7	21	8.22	3
Hingham,	11	–	11	12.58	–
Leominster,	29	6	35	9.62	1
Lexington,	–	2	2	11.60	–
Lincoln,	2	22	24	10.86	1
Littleton,	3	15	18	11.02	–
Lowell,	3	2	5	8.74	1
Marlborough,	13	4	17	9.16	2
Methuen,	3	2	5	10.94	–
Middleton,	14	–	14	12.30	–
Millis,	5	3	8	11.60	–
North Andover,	16	11	27	10.88	–
North Reading,	3	1	4	12.12	–
Northborough,	–	14	14	11.42	3
Norwood,	13	12	25	9.90	5
Peabody,	1	16	17	8.24	12
Pelham,	13	3	16	11.76	–
Randolph,	9	–	9	12.20	–
Raynham,	8	1	9	12.14	–
Rochester,	5	2	7	10.86	2
Royalston,	1	1	2	12.11	–
Sharon,	9	1	10	10.46	1

Milk from Suspected Producers — Concluded.

Locality.	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample (Per Cent.).	Number of Samples containing Added Water.
Sutton,	3	6	9	10.46	3
Swansea,	–	8	8	11.08	4
Topsfield,	9	7	16	10.64	–
Wellesley,	2	–	2	13.06	–
Westborough,	13	7	20	11.22	–
Weymouth,	1	1	2	10.16	2
Totals,	359	275	634	8.22	71

Summary of Milk Statistics.

	Number above Standard.	Number below Standard.	Total Samples collected.	Total Solids in Lowest Sample.	Number of Samples of Skimmed Milk.	Number of Samples colored with Orange Dye.	Number of Samples containing Added Water.
Cities,	1,770	455	2,225	8.27	24	1	69
Towns,	1,404	297	1,701	7.43	18	–	45
Suspected producers,	359	275	634	8.22	–	–	71
Miscellaneous,	51	–	51	12.25	–	–	–
Totals,	3,584	1,027	4,611	7.43	42	1	185

List of Adulterated Milk Samples.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum.	Remarks.
Roger S. Abbott,	Beverly,	10.58	3.55	–	7.03	33.5	Watered.
Meriano D. Arude,	Raynham,	12.24	4.40	–	7.84	35.7	Watered.
Geo. L. Averill,	Andover,	10.91	2.15	3.37	8.76	–	Skimmed.
Wm. H. Bansley,	Haverhill,	10.66	3.50	–	7.16	33.7	Watered.
		10.86	3.40	–	7.46	34.0	Watered.
Geo. H. Bateman,	Norwood,	11.24	2.95	3.12	8.29	35.7	Skimmed and watered.
Bay State Milk Co., Frank E. Chandler, proprietor.	Medford,	11.44	2.85	3.27	8.59	–	Skimmed.
		10.62	2.75	–	7.87	35.0	Watered.
John Bedard,	Rochester,	11.82	3.80	–	8.02	34.2	Watered.
		10.86	3.60	–	7.62	33.8	Watered.

List of Adulterated Milk Samples — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum.	Remarks.
Geo. E. Blake,	Lenox,	11.80	2.80	3.27	9.00	-	Skimmed.
Adolph Bouchard,	Dracut,	11.50	3.40	-	8.10	35.5	Watered.
Andrew C. Boynton,	Lanesborough,	12.28	4.50	-	7.78	34.9	Watered.
James Breen,	Concord,	9.54	2.60	-	6.94	34.0	Watered.
		11.24	2.90	3.23	8.34	36.6	Skimmed.
		10.00	3.00	-	7.00	33.8	Watered.
Wm. E. Briggs,	Taunton,	11.20	3.60	-	7.60	35.1	Watered.
Albert H. Brown,	Harvard,	10.20	2.30	-	7.90	35.8	Watered.
Edward O. Brown,	Gloucester,	10.60	3.45	-	7.15	35.2	Watered.
John A. Burgner,	Dalton,	11.87	2.90	3.46	8.97	-	Skimmed.
		9.45	3.20	-	6.25	32.1	Watered.
Bartholomew J. Carroll,	Natick,	11.08	3.40	-	7.68	34.7	Watered.
		10.98	3.35	-	7.67	34.7	Watered.
		10.91	3.30	-	7.61	34.7	Watered.
		10.96	3.40	-	7.56	34.6	Watered.
		11.10	3.60	-	7.50	34.2	Watered.
		11.16	3.65	-	7.51	34.2	Watered.
		11.20	3.55	-	7.65	34.1	Watered.
		11.30	3.75	-	7.65	34.1	Watered.
Henry H. Chamberlain,	Westwood,	11.70	4.25	-	7.47	34.8	Watered.
		12.44	4.35	-	8.09	35.5	Watered.
		11.00	3.40	-	7.80	35.5	Watered.
		11.00	3.00	-	8.00	35.5	Watered.
		9.90	2.85	-	7.05	33.9	Watered.
Frank Chapman,	Dunstable,	11.24	3.90	-	7.34	34.7	Watered.
		12.00	4.65	-	7.35	35.1	Watered.
		11.98	4.40	-	6.98	34.3	Watered.
Monroe B. Chesley,	Amesbury,	11.00	2.80	3.24	8.20	36.6	Skimmed.
		10.40	2.90	-	7.50	34.2	Watered.
		11.06	3.40	-	7.66	35.0	Watered.
		10.13	3.10	-	7.03	33.7	Watered.
		11.09	3.30	-	7.70	35.0	Watered.
David F. Clarke,	Topsfield,	10.64	2.45	2.90	8.19	-	Skimmed.
Dennis Cohan,	Quincy,	10.90	3.70	-	7.20	33.5	Watered.
Thomas Connelley,	Gloucester,	7.72	1.10	-	6.62	32.7	Watered.

List of Adulterated Milk Samples — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum.	Remarks.
Isaac B. Cook,	Lincoln,	11.56	3.60	–	7.96	35.6	Watered.
Charles Cox,	Beverly,	11.17	3.90	–	7.27	34.2	Watered.
Wm. P. Crowley,	Newton,	10.14	3.10	–	7.04	34.7	Watered.
		10.44	3.10	–	7.34	35.1	Watered.
		10.40	3.10	–	7.30	35.0	Watered.
Daniel E. Cummings,	Peabody,	10.10	3.85	–	6.25	31.9	Watered.
		10.05	3.65	–	6.40	32.0	Watered.
		9.24	3.10	–	6.14	31.4	Watered.
		9.53	3.00	–	6.53	32.4	Watered.
		10.00	4.10	–	5.90	31.7	Watered.
		9.50	3.05	–	6.45	32.1	Watered.
		11.10	4.35	–	6.75	33.1	Watered.
		9.56	3.20	–	6.36	31.9	Watered.
		10.08	3.65	–	6.43	32.2	Watered.
		10.06	3.90	–	6.16	32.2	Watered.
		8.24	2.20	–	6.04	31.4	Watered.
Wm. E. Daily,	South Braintree,	9.94	3.30	–	6.64	33.6	Watered.
John P. Dowling,	Pittsfield,	12.00	4.00	–	8.00	35.6	Watered.
Michael J. Driscoll,	North Andover,	10.94	3.80	–	7.14	34.5	Watered.
Martin E. Eagan,	Pittsfield,	10.69	3.70	–	6.99	34.0	Watered.
		10.52	3.40	–	7.12	34.1	Watered.
Robert Evans,	Wood's Hole,	10.50	3.20	–	7.30	34.0	Watered.
Morris E. Field,	Greenfield,	7.43	0.10	–	7.33	34.2	Watered.
John C. Fox,	Lamena Road, Dracut,	8.74	3.60	–	6.14	32.6	Watered.
		9.50	2.70	–	6.80	33.0	Watered.
Albert L. Forbush,	Braintree,	10.36	2.70	–	7.66	35.2	Watered.
		11.22	3.60	–	7.68	35.4	Watered.
		11.63	3.60	–	8.03	35.4	Watered.
Emma G. Forbush,	Braintree,	10.80	2.60	2.99	8.20	–	Skimmed.
Alexander A. Francis,	Truro,	11.44	3.90	–	7.54	34.7	Watered.
Albert H. Friend,	Gloucester,	7.80	2.55	–	5.25	30.7	Watered and colored.
Edward J. Fuller,	Sharon,	10.46	3.40	–	7.06	33.1	Watered.
Gloucester Dairy Company,	Gloucester,	11.12	3.30	–	7.82	35.8	Watered.
Geo. H. Gould,	Taunton,	10.71	3.10	–	7.61	34.5	Watered.

List of Adulterated Milk Samples — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum.	Remarks.
Hubert H. Hall,	Great Barrington,	10.86	3.20	-	7.06	33.5	Watered.
		8.94	2.35	-	6.59	33.0	Watered.
Oscar M. Hall,	Great Barrington,	11.12	3.40	-	7.72	35.7	Watered.
		11.34	3.60	-	7.74	35.7	Watered.
Leonard Hammer,	Monterey,	12.00	4.00	-	8.00	35.6	Watered.
		11.00	3.90	-	7.10	33.9	Watered.
John H. Hargrave,	Lexington,	11.68	2.60	3.41	9.05	-	Skimmed.
Charles W. Harris,	Leominster,	10.66	3.20	-	7.46	35.4	Watered.
Robert Hargrove,	Woburn,	12.25	4.00	-	8.25	35.4	Watered.
		12.14	4.15	-	7.99	35.5	Watered.
H. P. Hood & Sons,	Boston,	11.20	3.30	-	7.90	35.2	Watered.
		9.54	2.80	-	6.74	34.4	Watered.
Adelbert L. Huntington,	Pittsfield,	11.29	3.70	-	7.59	35.8	Watered.
John A. Johnson,	North Adams,	10.88	2.00	3.40	8.88	-	Skimmed.
Geo. Kafalas,	Ipswich,	11.20	3.30	-	7.90	35.8	Watered.
Aharon Kasbaian,	Andover,	10.36	2.90	-	7.46	35.4	Watered.
		10.86	3.25	-	7.61	35.2	Watered.
		10.66	3.30	-	7.36	32.2	Watered.
		11.14	3.25	-	7.89	35.4	Watered.
		11.00	3.35	-	7.65	35.6	Watered.
		10.10	2.60	-	7.50	35.6	Watered.
		10.86	3.30	-	7.56	35.3	Watered.
		11.40	3.50	-	7.90	35.3	Watered.
		10.74	3.10	-	7.64	35.5	Watered.
		11.50	3.80	-	7.70	35.3	Watered.
		11.60	3.70	-	7.90	35.9	Watered.
		11.66	3.80	-	7.86	35.7	Watered.
		11.10	3.30	-	7.80	35.4	Watered.
		11.22	3.55	-	7.67	35.4	Watered.
		10.42	3.60	-	7.32	35.5	Watered.
		11.12	3.55	-	7.57	35.4	Watered.
Harold N. Kee,	Warren, R. I.,	11.08	3.10	-	7.98	35.5	Watered.
		11.08	3.10	-	7.98	35.6	Watered.
		11.08	3.00	-	8.08	35.5	Watered.
		11.08	3.05	-	8.03	35.5	Watered.

List of Adulterated Milk Samples — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum.	Remarks.
Orrin H. Keith,	Attleborough,	11.06	3.55	–	7.51	34.7	Watered.
		11.13	3.50	–	7.63	35.0	Watered.
William A. Kimball,	Stoughton,	11.70	2.90	3.49	8.80	–	Skimmed.
Levi F. King,	Dartmouth,	11.30	3.40	–	7.90	35.4	Watered.
Jacob F. Kirchner,	Pittsfield,	12.00	4.30	–	7.70	35.1	Watered.
Lycourzois Lampros,	Lowell,	13.35	6.25	–	7.10	35.1	Watered.
Frank Loehr,	Pittsfield,	10.86	3.55	–	7.31	34.8	Watered.
		10.32	3.00	–	7.32	33.9	Watered.
		11.60	3.70	–	7.90	35.7	Watered.
Joseph Loehr,	Pittsfield,	10.90	3.00	–	7.90	35.5	Watered.
		11.34	3.90	–	7.44	35.1	Watered.
Charles R. Luther,	Sutton,	11.74	3.70	–	8.04	35.8	Watered.
Elizabeth H. Luther,	Sutton,	10.46	3.15	–	7.31	33.5	Watered.
		11.04	3.15	–	7.89	34.0	Watered.
Harry Mack,	Winchendon,	11.84	2.90	3.37	8.94	–	Skimmed.
Geo. W. Mansfield,	Lynn,	8.42	0.30	–	8.12	34.5	Watered.
Harry R. Mason,	Beverly,	11.12	3.50	–	7.62	35.3	Watered.
James McCormick,	Chelmsford,	10.92	3.10	–	7.82	35.4	Watered.
		10.94	3.20	–	7.74	35.0	Watered.
		10.91	3.20	–	7.71	35.2	Watered.
		11.06	3.20	–	7.86	35.3	Watered.
		11.20	3.70	–	7.80	35.5	Watered.
		11.20	3.70	–	7.80	35.5	Watered.
		10.30	3.30	–	7.00	35.5	Watered.
		12.12	3.30	–	8.82	35.5	Watered.
		10.94	3.20	–	7.74	35.5	Watered.
Thos. J. McDonough,	Hyde Park,	11.03	3.35	–	7.68	35.1	Watered.
James P. McNiff,	Marlborough,	11.16	3.00	–	8.16	35.4	Watered.
Wm. McNiff,	Marlborough,	10.60	3.90	–	6.70	33.4	Watered.
		11.80	3.80	–	7.00	33.7	Watered.
John G. McPhee,	Ipswich,	9.28	3.10	–	6.72	33.8	Watered.
		9.70	3.00	–	6.70	33.5	Watered.
Harry Medlyn,	Richmond,	12.00	4.20	–	7.80	35.0	Watered.
		10.32	2.80	–	7.52	34.7	Watered.
Samuel Mills,	Westminster,	11.14	3.40	–	7.74	35.9	Watered.

List of Adulterated Milk Samples — Continued.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum.	Remarks.
Frank T. Moore, . . .	Peabody, ...	11.04	3.50	-	7.54	35.6	Watered.
Dell. H. Morse, . . .	Gardner, ...	9.50	1.92	2.30	7.60	36.1	Skimmed.
John C. Moynihan, . .	Newburyport, . .	10.66	3.30	-	7.36	34.4	Watered.
North Shore Dairy Association.	Gloucester, . .	11.80	4.30	-	7.50	34.5	Watered.
		9.20	1.80	-	7.40	34.1	Watered.
		11.00	3.30	-	7.70	35.7	Watered.
		11.00	3.30	-	7.70	35.4	Watered.
James F. Otis, . . .	Weymouth, . . .	10.10	2.60	-	7.50	34.5	Watered.
John Parker, . . .	Raynham, . . .	11.06	3.65	-	7.41	34.1	Watered.
Ernest A. Peck, . . .	Montello, . . .	10.72	3.40	-	7.32	35.6	Watered.
Edward A. Piper, . .	Ashby, ...	8.32	0.80	-	7.52	35.3	Watered.
John A. Porter, . . .	Woburn, . . .	11.84	3.40	3.39	8.44	-	Skimmed.
Charles C. Putnam, . .	Peabody, . . .	10.80	3.50	-	7.30	34.1	Watered.
Willard O. Putnam, . .	North Andover, .	9.34	2.80	-	6.54	33.0	Watered.
		11.24	2.75	3.10	8.49	37.0	Skimmed.
Louis Reynolds, . . .	Westminster, . .	11.46	4.00	-	7.46	35.0	Watered.
Daniel L. Reynolds, . .	Haverhill, . .	11.40	3.60	-	7.80	35.0	Watered.
		9.85	3.00	-	6.85	33.3	Watered.
		10.34	3.00	-	7.34	34.6	Watered.
		11.12	3.40	-	7.72	34.6	Watered.
		11.12	3.40	-	7.72	35.8	Watered.
		11.09	3.20	-	7.89	35.5	Watered.
Henry Rich, . . .	Milford, . .	11.16	3.50	-	7.66	35.4	Watered.
		10.40	2.80	-	7.60	34.5	Watered.
Daniel Riley, . . .	Weymouth, . .	10.16	3.80	-	6.36	31.6	Watered.
		12.20	4.30	-	7.90	34.9	Watered.
Joseph Rogers, . . .	North Andover, .	11.00	3.40	-	7.60	35.2	Watered.
Frank J. Rooney, . .	Marlborough, .	12.08	3.70	-	8.38	35.5	Watered.
		12.02	3.80	-	8.22	35.5	Watered.
Royler's Restaurant, . .	New Bedford, . .	10.23	1.60	3.86	8.63	-	Skimmed.
E. T. Sawyer, . . .	Rockport, . . .	10.46	1.85	3.13	8.61	38.6	Skimmed.
Max W. Schraut, . .	Braintree, . . .	10.54	2.00	3.01	8.54	-	Skimmed.
Wm. A. Shepperd, . .	Hyde Park, . . .	11.26	2.60	3.18	8.66	-	Skimmed.
Michael L. Sullivan, . .	Lowell, ...	10.66	3.15	-	7.51	34.1	Watered.
Jabez R. Summersgill, .	Lawrence, . . .	8.27	0.30	-	7.97	35.5	Watered.

List of Adulterated Milk Samples — Concluded.

Dealer.	Locality.	Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum.	Remarks.
Olin E. Swan,	South Framingham,	11.56	2.80	3.23	8.76	-	Skimmed.
George H. Swift,	Berkley,	11.60	4.00	-	7.60	34.6	Watered.
Michael L. Tavitian,	Plaistow, N. H.,	11.06	3.60	-	7.46	35.0	Watered.
		8.92	2.70	-	6.22	33.2	Watered.
Joseph Teot,	Pittsfield,	12.00	4.40	-	7.60	35.8	Watered.
		12.12	4.20	-	7.92	35.8	Watered.
		11.33	3.40	-	7.93	35.8	Watered.
James A. Torrey,	Pittsfield,	11.80	4.30	-	7.50	35.0	Watered.
Henry M. Wade,	Stockbridge,	12.00	4.40	-	7.80	35.7	Watered.
Henry H. Wehry,	Dalton,	11.16	2.80	3.00	8.36	-	Skimmed.
Willis E. Wheeler,	Northborough,	11.42	3.60	-	7.82	35.4	Watered.
		11.77	4.00	-	7.77	35.9	Watered.
Eliot M. Whitcomb,	Winchendon,	11.32	2.80	3.23	8.52	-	Skimmed.
Edward C. Wright,	Chelmsford,	10.49	2.90	-	7.59	34.5	Watered.

During the year the determinations of total solids and fat were made upon all the samples of milk collected. These determinations are compiled in the two following tables: —

Quality of Milk, by Months.

Samples.	1908.	1909.											Total.
	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	
Number having more than 15 per cent. total solids.	3	3	5	17	1	6	4	5	3	13	16	8	84
Number having between 14 and 15 per cent total solids.	22	27	17	42	7	32	20	23	12	21	41	24	288
Number having between 13 and 14 per cent. total solids.	85	92	54	123	86	170	86	90	91	153	118	118	1,266
Number having between 12.15 and 13 per cent. total solids.	119	109	96	112	81	221	221	233	157	267	122	186	1,924
Number having between 11 and 12.15 per cent. total solids.	36	34	27	30	40	85	108	151	124	114	38	77	864
Number having between 10 and 11 per cent. total solids.	5	2	3	6	2	5	9	18	16	30	13	4	113
Number having between 9 and 10 per cent. total solids.	4	5	4	3	3	3	6	6	8	6	7	2	57
Number having between 8 and 9 per cent. total solids.	2	1	1	1	-	-	1	2	3	1	-	-	12

Quality of Milk, by Months — Concluded.

SAMPLES.	1908. December.	1909. January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	Total.
Number having less than 8 per cent. total solids.	–	1	–	–	–	–	–	1	1	–	–	–	3
Number of samples of skimmed milk above the standard.	2	2	3	2	–	2	1	2	2	4	2	–	22
Number of samples of skimmed milk below the standard.	–	3	3	–	2	1	1	–	6	3	–	1	20
Number of samples of colored milk, .	–	–	–	–	–	–	–	–	1	–	–	–	1
Number of samples of preserved milk, .	–	–	–	–	–	–	1	–	–	–	–	–	1
Number of samples of watered milk, .	9	4	3	4	4	8	16	23	31	39	33	11	185
Number of samples above the standard,	231	233	175	296	175	431	332	353	265	458	299	336	3,584
Number of samples below the standard,	45	41	32	38	45	91	123	176	150	147	56	83	1,027
Total samples collected, ...	276	274	207	334	220	522	455	529	415	605	355	419	4,611

The table of quality of milk, by months, will show that 77.22 per cent. of the samples collected were above the standard of total solids, and 35.6 per cent. were above 13 per cent. in total solids. It is manifestly impossible to arrive at the exact composition of the average milk on sale in this State, for the following reasons: there is no way of arriving at a conclusion except by the study of samples collected by inspectors, and inspections as a rule are more frequent in localities where milk is most extensively adulterated, and least where the sale of a high quality of milk is the rule. Owing to the increasing demand in summer resorts, cities and towns, the milk on sale in the summer months is extensively adulterated, while that supplied in the winter is as a rule of good quality. The character of milk varies with the locality: thus, milk on sale in towns is of a better quality than milk sold in cities, and milk in the western part is superior to that of the eastern part of the State. It is evident, therefore, that any conclusion drawn from the work of the food inspection departments of the Massachusetts State Board of Health will point to a sale of a lower average quality of milk than is actually the case.

The table on page 456 shows the quality of the average milk collected. In making these averages all samples of cream were eliminated, and the first set of figures gives the average solids, fat and solids not fat of all samples collected, including skimmed and watered samples. In the second set of figures the skimmed and watered samples have been excluded. On looking over the averages, we find the lowest solids occur

in the month of July; and even this average, including as it does more than 10 per cent. of adulterated samples, is considerably above the legal standards. It may also be mentioned that during this month a large number of samples were taken from suspected producers, a good many of whom were either adulterating their milk or had herds of cows giving an abnormally low standard of milk. The average for the year of 4,534 samples was 12.63 per cent. total solids and 3.91 per cent. fat. After eliminating the skimmed and watered samples, we had 4,242 samples with an average total solids of 12.78 per cent. and an average fat of 4.01 per cent.

Quality of Average Milk Collected.

MONTHS.	Number of Samples.[1]	Average Total Solids (Per Cent.).	Average Fat (Per Cent.).	Average Solids not Fat (Per Cent.).	Number of Samples.[2]	Average Total Solids (Per Cent.).	Average Fat (Per Cent.).	Average Solids not Fat (Per Cent.).
December, . .	259	12.65	3.85	8.80	248	12.77	3.92	8.85
January, . .	274	12.67	3.72	8.95	263	12.77	3.83	8.94
February, . .	201	12.74	3.94	8.80	192	12.85	4.04	8.81
March, . . .	291	13.09	4.18	8.91	283	13.19	4.25	8.94
April, . . .	215	12.75	3.96	8.79	209	12.82	4.01	8.81
May, . . .	517	12.78	3.99	8.81	500	12.84	4.02	8.82
June, . . .	450	12.56	3.87	8.69	424	12.71	3.93	8.78
July, . . .	529	12.21	3.82	8.39	496	12.52	3.89	8.63
August, . .	409	12.31	3.78	8.53	363	12.55	3.92	8.63
September, . .	618	12.48	3.95	8.53	558	12.66	4.05	8.61
October, . .	355	12.95	4.19	8.76	321	13.09	4.28	8.81
November, . .	416	12.77	3.99	8.78	385	12.89	4.06	8.83
Year, . .	4,534	12.63	3.91	8.72	4,242	12.78	4.01	8.77

[1] Total samples collected exclusive of cream and known purity samples.
[2] Above samples exclusive of those declared skimmed or watered.

In view of these facts, there seems to be no reason why our milk standards should be lowered. If nearly 80 per cent. of the samples collected by our inspectors (and that undoubtedly means 85 per cent. or 90 per cent. of the milk upon the market) is above the standard, there is no reason why the rest should not be so.

The copper method of preparing milk serum mentioned in the report of 1908 has been used throughout the year with excellent results. All the analyses of known purity samples examined during the year have corroborated our previous experience with this method. The method is as follows: dissolve 72.5 grams of crystalized copper sulphate in water and dilute to 1 liter. If this solution does not refract at 36 on the scale

of the immersion refractometer at 20°, add water or copper sulphate until the desired result is obtained. To 8 cubic centimeters of the copper solution add 32 cubic centimeters of milk. Shake well and pour upon a filter. When the filtrate begins to come through clear, change the receiver, pour the small quantity of cloudy filtrate upon the filter and continue the filtration as usual. Refract the clear filtrate at 20° C., by means of the Zeiss immersion refractometer. A reading below 36 indicates added water. The advantages of this method over the acetic acid method are as follows: it is quicker, heating of the samples is unnecessary, consequently there is no error due to evaporation. The variation in the refraction of pure milk is less. Ten per cent. of added water will reduce the refraction of high-grade milk below the minimum, where it takes 15 per cent. in the case of the acetic acid method. Analyses have been made by this method of 150 samples of milk of known purity. The total solids varied from 17.17 per cent. to 10.40 per cent., the fat from 7.7 to 2.45, the solids not fat from 10.50 to 7.5, and the refraction of the copper serum varied from 36.1 to 39.5. These copper refractions are distributed as follows: —

Refraction.	Number of Samples.
39.0 to 39.5,	6
38.0 to 38.9,	66
37.0 to 37.9,	65
36.1 to 36.9,	13
	150

The samples of herd milk gave refractions as follows: —

Highest,	38.6
Lowest,	37.2
Average,	37.9

A composite sample of laboratory milk was divided into two portions, one portion watered (25 per cent.), sera prepared, and analyses made, with the following results: —

Composition of Milk.	Whole Milk (Per Cent.).	Watered Milk (Per Cent.).
Total solids,	12.08	9.06
Fat,	3.50	2.65
Solids not fat,	8.50	6.41

Composition of Serum.	Whole Milk.	Watered Milk.
Specific gravity 15° C.,	1.0280	1.0234
Refraction 20° C.,	37.3	32.6
	Per Cent.	Per Cent.
Total solids,	6.21	4.85
Milk sugar,	4.32	3.23
Proteids,	0.59	0.39
Ash,	0.83	0.79
Copper,	0.212	0.253

Composition of a Sample of Milk Systematically Watered.

Added Water (Per Cent.).	Total Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Refraction of Copper Serum, 20° C.
0,	13.66	4.65	8.95	38.1
10,	12.24	4.18	8.06	35.8
20,	10.88	3.72	7.16	33.8
30,	9.52	3.25	6.27	32.0
40,	8.16	2.79	5.37	30.1
50,	6.80	2.33	4.47	28.3

One hundred and forty-six samples of milk of known purity, representing many breeds and various stages of lactation, were arranged in the order of the total solids, and averages made of each 10 samples (1 to 10, 2 to 11, 3 to 12 inclusive, etc.). The maximum variation in the total solids of the samples represented in each average was 0.7, and from these 126 averages were taken those which varied exactly by 0.1 in the total solids, with 0 in the second decimal. In some cases an average could not be found without a figure in the second decimal place in the solids, and then averages of two or more of the first averages were made to accomplish this purpose; for example, 12.22 and 12.18 would be averaged to produce 12.20; the variation of the solids in these latter cases was less than 0.07. These figures will represent the average mixed milk of individual cows with but little variation in the total solids, and they are given in the following table: —

Average of Analyses of Milk of Known Purity from Individual Cows.

[Ten analyses used to obtain each average; maximum variation of total solids, 0.7.]

Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Ash (Per Cent.).	Solids not Fat (Per Cent.).	Milk Sugar (Per Cent.).	Refraction of Copper Serum, 20° C.
15.70	6.01	4.13	0.77	9.69	4.79	38.1
15.60	5.87	4.07	0.77	9.73	4.89	38.3
15.50	5.87	3.96	0.75	9.63	4.92	38.4
15.40	5.75	3.87	0.76	9.65	5.02	38.4
15.30	5.75	3.75	0.75	9.55	5.05	38.5
15.20	5.67	3.71	0.74	9.53	5.08	38.5
15.10	5.58	3.80	0.74	9.52	4.98	38.4
15.00	5.62	3.75	0.76	9.38	4.87	38.3
14.90	5.52	3.71	0.76	9.38	4.91	38.3
14.80	5.51	3.65	0.78	9.29	4.86	38.2
14.70	5.40	3.70	0.79	9.30	4.81	38.1
14.60	5.30	3.72	0.79	9.30	4.79	38.1
14.50	5.30	3.61	0.77	9.20	4.82	38.3
14.40	5.21	3.63	0.75	9.19	4.81	38.3
14.30	5.19	3.58	0.74	9.11	4.79	38.3
14.20	5.05	3.51	0.72	9.15	4.92	38.6
14.10	4.92	3.52	0.71	9.18	4.93	38.6
14.00	4.78	3.51	0.73	9.22	4.98	38.5
13.90	4.67	3.52	0.74	9.23	4.97	38.4
13.80	4.69	3.44	0.73	9.11	4.94	38.3
13.70	4.59	3.43	0.73	9.11	4.95	38.3
13.60	4.67	3.40	0.75	8.93	4.78	38.0
13.50	4.61	3.37	0.75	8.89	4.77	38.1
13.40	4.51	3.22	0.75	8.89	4.92	38.1
13.30	4.47	3.07	0.73	8.83	5.03	38.0
13.20	4.55	2.99	0.74	8.65	4.92	37.9
13.10	4.55	2.86	0.74	8.55	4.95	37.8
13.00	4.24	3.17	0.73	8.76	4.86	37.9
12.90	4.06	3.26	0.74	8.84	4.84	38.0
12.80	4.00	3.20	0.72	8.80	4.88	37.9
12.70	3.97	3.08	0.73	8.73	4.92	38.0
12.60	4.04	3.02	0.72	8.56	4.82	37.9
12.50	3.99	2.84	0.73	8.51	4.94	38.0
12.40	3.94	2.83	0.72	8.46	4.91	38.0
12.30	3.89	2.81	0.72	8.41	4.88	37.9
12.20	3.81	2.81	0.75	8.39	4.83	37.8

Average of Analyses of Milk of Known Purity from Individual Cows — Concluded.

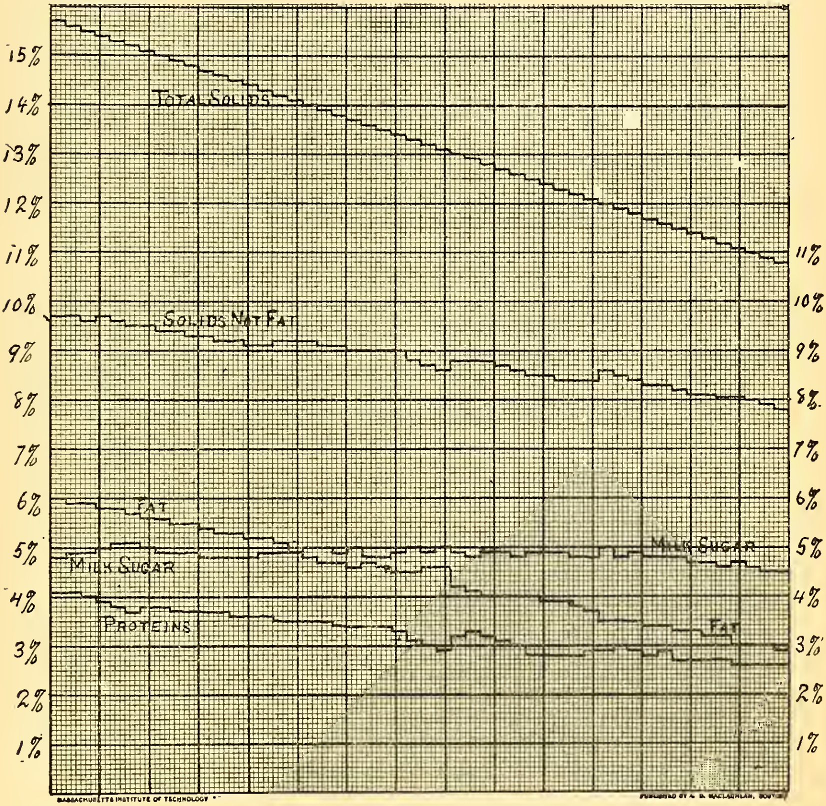
Total Solids (Per Cent.).	Fat (Per Cent.).	Proteids (Per Cent.).	Ash (Per Cent.).	Solids not Fat (Per Cent.).	Milk Sugar (Per Cent.).	Refraction of Copper Serum, 20° C.
12.10	3.66	2.88	0.74	8.44	4.82	37.7
12.00	3.45	2.88	0.71	8.55	4.96	37.7
11.90	3.45	3.07	0.69	8.45	4.70	37.6
11.80	3.45	2.87	0.71	8.35	4.77	37.6
11.70	3.40	2.78	0.69	8.30	4.83	37.7
11.60	3.35	2.80	0.69	8.25	4.76	37.5
11.50	3.33	2.67	0.70	8.17	4.80	37.3
11.40	3.29	2.73	0.71	8.11	4.67	37.2
11.30	3.20	2.67	0.70	8.10	4.73	37.4
11.20	3.15	2.71	0.72	8.05	4.62	37.1
11.10	3.04	2.69	0.73	8.06	4.64	37.0
11.00	3.02	2.64	0.71	7.98	4.63	37.0
10.90	2.99	2.63	0.71	7.91	4.57	36.8
10.80	2.95	2.60	0.71	7.85	4.54	36.6
10.70	2.90	2.60	0.71	7.80	4.49	36.4

It will be noticed from a study of these figures that all the constituents are lowered as the solids become less. The fat is reduced the most, the proteins somewhat less, the sugar and the ash the least. The sugar can be said to be fairly constant, varying from 4.49 to 5.03 per cent. This gives a maximum variation of 10.7 per cent., with an average variation of about ± 6 per cent., and the ash, while its percentage variation is considerable, the actual variation is but slight. We can say that the greatest variables are the fat and the proteins, and to these is due the variation of the solids, and to the proteins is due the variation of the solids not fat. It is upon the fact of the constancy of the milk sugar that nearly all the methods for the detection of added water depend, such as the specific gravity of the serum, refraction of the serum, ash of the serum, acidity of the sour milk; and by these means adulteration with water of from 10 to 15 per cent. upwards can be detected, even if the solids, fat, and solids not fat are fairly normal. This fact may, strange to say, be used to detect skimming as well as watering. It has been shown by Olson [1] that we may calculate the proteins from the total solids by the following formula: $\text{T. S.} - \frac{\text{T. S.}}{1.34} = \text{P.}$ This will

[1] Jour. Ind. Eng. Chem., 1, 256.

be approximately correct only if the sample is pure. If, however, the sample is skimmed, the calculated proteins will be too low, as skimming will lower the total solids, while the proteins will remain the same. If we take the calculated proteins, add to it the fat and 0.7 for the ash, we obtain the solids not sugar, and upon subtracting this from the total solids we get the calculated sugar. From our knowledge of the com-

Relation between the Constituents of Pure Milk.



position of milk, we know that this figure rarely exceeds 5 per cent. If the calculated proteins are low, which will be true in the case of skimmed milk, the calculated sugar will be high; and if it exceeds 5 per cent., we can be reasonably sure the sample has been skimmed. We have found that for practical purposes samples having sugar between 4.2 and 4.8 calculated by the above method are pure milk. If the calculated sugar exceeds 4.8, the sample may be suspected of being skimmed, and if less than 4.2, the sample may be watered; and further examina-

tion should be made, such as actual protein determination in the case of skimmed milk and refraction of the serum in the case of watered milk. Van Slyke has shown (Jour. Am. Chem. Soc., 30–1166) that a relation exists between the proteins and the fat, and that the proteins can be approximately calculated from the fat by the formula $0.4(F - 3) + 2.8 = P$. This formula, as well as Olson's, may be used in calculating the sugar by difference, and the figures will be nearly the same in pure samples, but will differ in adulterated samples.

A table has been prepared calculating these figures both by Olson's formula and by Van Slyke's formula, in the latter case the calculation being made from the fat. From this table the following figures have been taken, showing the range of fat and solids not fat in pure milk, varying in solids from 10.5 to 14 per cent. If the fat is higher than that stated in the table, the milk has probably been watered; if less, it may be skimmed. It should be stated that if a sample is both skimmed and watered, it may fall in the class of good milk.

Composition of Milk Probably not Adulterated.

Total Solids (Per Cent.).	Fat.		Solids not Fat.		Total Solids (Per Cent.).	Fat.		Solids not Fat.	
	Minimum (Per Cent.).	Maximum (Per Cent.).	Minimum (Per Cent.).	Maximum (Per Cent.).		Minimum (Per Cent.).	Maximum (Per Cent.).	Minimum (Per Cent.).	Maximum (Per Cent.).
10.5	2.5	2.7	7.8	8.0	12.3	3.7	4.0	8.3	8.6
10.6	2.5	2.8	7.8	8.1	12.4	3.7	4.1	8.3	8.7
10.7	2.6	2.9	7.8	8.1	12.5	3.8	4.1	8.4	8.7
10.8	2.6	3.0	7.8	8.2	12.6	3.9	4.2	8.4	8.7
10.9	2.7	3.0	7.9	8.2	12.7	3.9	4.2	8.5	8.8
11.0	2.8	3.1	7.9	8.2	12.8	4.0	4.3	8.5	8.8
11.1	2.8	3.2	7.9	8.3	12.9	4.1	4.4	8.5	8.8
11.2	2.9	3.2	8.0	8.3	13.0	4.1	4.5	8.5	8.9
11.3	3.0	3.3	8.0	8.3	13.1	4.2	4.5	8.6	8.9
11.4	3.1	3.4	8.0	8.3	13.2	4.2	4.6	8.6	9.0
11.5	3.1	3.5	8.0	8.4	13.3	4.3	4.6	8.7	9.0
11.6	3.2	3.5	8.1	8.4	13.4	4.3	4.7	8.7	9.1
11.7	3.3	3.6	8.1	8.4	13.5	4.4	4.8	8.7	9.1
11.8	3.3	3.7	8.1	8.5	13.6	4.5	4.8	8.8	9.1
11.9	3.4	3.7	8.2	8.5	13.7	4.5	4.9	8.8	9.2
12.0	3.5	3.8	8.2	8.5	13.8	4.6	5.0	8.8	9.2
12.1	3.5	3.9	8.2	8.6	13.9	4.7	5.0	8.9	9.2
12.2	3.6	3.9	8.3	8.6	14.0	4.8	5.1	8.9	9.2

Cream.

One hundred and seventy-one samples of cream were examined, 7 of which were adulterated. One of these 7 samples contained less than 15 per cent. of fat; 1 not collected by an inspector but submitted to us for examination was sour, and contained added calcium; and 5 contained calcium sucrate. The quality of the cream collected this year is much superior to that of last year. This is due to the method of detecting calcium sucrate which was discovered in 1908. It was a well-known fact among cream dealers that calcium sucrate could be added to cream and the addition could not be detected. When the Baier and Neumann method was first used in this laboratory nearly all the cream on the market gave a test for cane sugar. Soon after notifications were sent out and prosecutions begun this variety of cream entirely disappeared from the market with phenomenal rapidity, and also the amount of calcium in the market cream was materially reduced. Our experience with the Baier and Neumann tests shows that it is reliable, and this opinion is based upon the examination of 245 samples of cream collected upon the Massachusetts markets, several samples of known purity cream and about 100 samples of known purity milk, together with numerous samples of laboratory milk and samples of cream separated in the laboratory from market milk. All of these samples gave negative results. The details of the method are as follows: —

Baier and Neumann's Test for Cane Sugar in Milk and Cream.[1]

To 25 cubic centimeters of milk or cream add 10 cubic centimeters of a 5 per cent. solution of uranium acetate, shake well, allow to stand for five minutes and filter. To 10 cubic centimeters of the clear filtrate (in the case of cream use the total filtrate, which will be less than 10 cubic centimeters) add a mixture of 2 cubic centimeters saturated ammonium molybdate and 8 cubic centimeters dilute hydrochloric acid (1 part 25 per cent. acid and 7 parts water), and place in a water bath at a temperature of 80° C. for five minutes. If the sample contained sugar, the solution will be of a prussian blue color. This should always be compared in a colorimeter with the standard prussian blue solution prepared by adding a few drops of potassium ferrocyanide and 5 drops of 10 per cent. hydrochloric acid to a solution of 1 cubic centimeter of 0.1 per cent. ferric chloride in 20 cubic centimeters of water.

It has been claimed that pure milk will give this test. Occasional samples of pure milk will give a pale blue color, but this can be entirely removed by filtration, and the filtrate will be green; while the color due

[1] Z. Nahr. Generssom, 16, 51.

to sugar will pass through the filter, giving the usual blue solution characteristic of adulterated samples. The color produced is due to a reduction of the molybdic acid, and is produced by levulose and dextrose as well as by sucrose. Solutions of 1 gram of lactose, levulose, dextrose and sucrose in 35 cubic centimeters of water were used in comparing the amount of color produced when heated with the molybdenum reagent for five minutes. Lactose produced no color, levulose gave a heavy blue, sucrose a weaker blue and dextrose the weakest blue, corresponding in intensity as 10 : 3 : 1.

Stannous chloride and ferrous sulphate give this blue color, but the reaction takes place in the cold, and in small quantities the color disappears on heating. In order for the color to persist after heating the sample of cream must contain these substances to the extent of 1 per cent. calculated as the metal. In this case the sample will be completely coagulated and the taste will be very disagreeable. Hydrogen sulphide will also give the blue color, but it will disappear on heating. If the solution does not show the blue color before heating, it is free from hydrogen sulphide, ferrous sulphate and stannous chloride.

As a confirmatory test for sugar, the resocine test may be applied to the serum prepared with uranium as described above. This test is given by sucrose and levulose, but not by dextrose or lactose.

In making the determinations of calcium it was found that calcium varied considerably in different samples of cream. After a considerable number of samples had been examined it was noticed that the samples with the higher percentage of fat had the lower percentage of calcium. These figures were plotted, the percentage of calcium being used as ordinates and the percentage of fat as abscissæ.

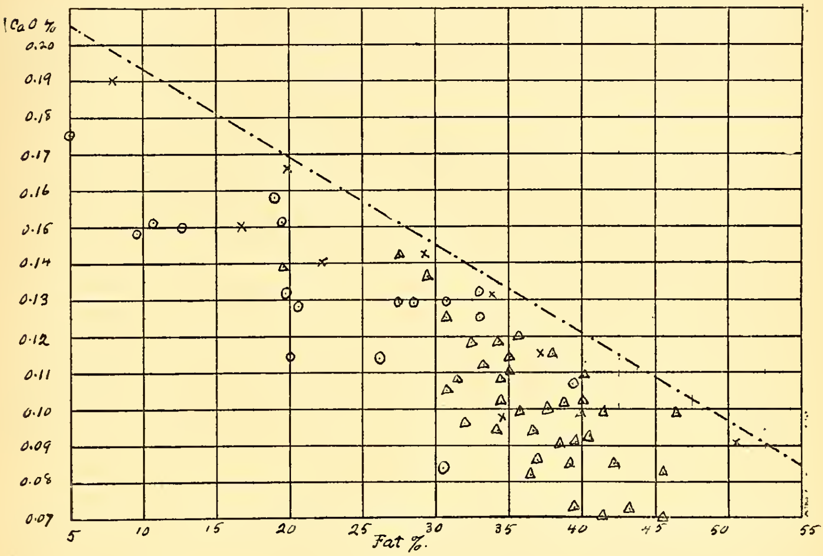
The method of determining the calcium is as follows: —

Determination of alkalinity of ash and calcium. Weigh 25 grams of cream into a platinum dish, place in an oven at about 125–150° C. over night, and burn to an ash in a muffle at a low red heat. Dissolve the ash in 20 cubic centimeters N/10 sulphuric acid, boil to expel the carbon dioxide and titrate back with N/10 sodium hydroxide using phenolphthalein as the indicator. Express results as cubic centimeters N/10 acid required to neutralize the ash of 100 grams of cream.

Make the final solution of the above determination acid with acetic acid, heat to boiling, add 1 gram of sodium acetate, and to the clear solution add an excess of ammonium oxalate, boil for a few minutes, filter and wash with water. Dissolve the calcium oxalate in hot dilute sulphuric acid and titrate hot with N/10 potassium permanganate. Cubic centimeters N/10 permanganate multiplied by 0.0112 (4×0.0028) gives the percentage of CaO in the sample.

The samples recorded upon the plot with crosses were of known purity, the cows being milked and the cream separated in the presence of an analyst of the State Board of Health. The samples recorded by the circles were separated in the laboratory from samples collected by the inspectors, and which upon analysis proved to be pure milk. Those marked with

Relation between Fat and CaO in Cream.



the triangles were commercial samples which gave no test for added sugar. There were many more samples between 35 and 45 per cent. of fat which were not recorded, as they were nearly coincident with recorded samples. From a study of the chart we obtain the following figures, giving the maximum amount of calcium oxide permissible to pure cream: —

Relation between Fat and Calcium in Cream.

Fat (Per Cent.).	Maximum CaO (Per Cent.).	Fat (Per Cent.).	Maximum CaO (Per Cent.).	Fat (Per Cent.).	Maximum CaO (Per Cent.).	Fat (Per Cent.).	Maximum CaO (Per Cent.).
15	0.181	25	0.156	35	0.132	45	0.108
16	0.178	26	0.154	36	0.129	46	0.106
17	0.175	27	0.151	37	0.127	47	0.103
18	0.173	28	0.149	38	0.124	48	0.100
19	0.171	29	0.146	39	0.122	49	0.098
20	0.169	30	0.144	40	0.120	50	0.096
21	0.166	31	0.141	41	0.118	51	0.093
22	0.164	32	0.139	42	0.115	52	0.090
23	0.161	33	0.137	43	0.113	53	0.088
24	0.158	34	0.134	44	0.110	54	0.085

It should be pointed out that the calcium in cream rarely reaches the highest figures, and this is especially true when it is made from pasteurized milk, as the heating will render some of the calcium insoluble and it will be removed from the cream in the separator, as our laboratory experiments have shown. A study of the plot will show that the samples of known purity cream and those separated in the laboratory were higher in calcium than the samples found upon the market, this being no doubt due to the fact that most of the market cream had been made from pasteurized milk. The following are the analyses of the samples of adulterated cream received during the year. All the samples of cream containing calcium sucrate except the one which was sour when submitted were traced to Daniel A. Neylon of Springfield, who was prosecuted, convicted and paid his fine. This cream was shipped into Springfield from New Hampshire, and was the only cream collected during the year adulterated with calcium sucrate. The sample of cream obtained after souring and which consequently gave no reaction for sugar was found to be strongly alkaline, using methyl orange as the indicator. By this means it is possible to detect added alkaline mineral compounds. Experiments upon samples of pure heavy cream show that it takes from 3 to 3.5 cubic centimeters of N/2 acid to neutralize 25 cubic centimeters of cream, using methyl orange as the indicator. The sample of cream in question required 7 cubic centimeters of acid for neutralization.

List of Adulterated Samples of Cream.

Fat (Per Cent.).	Ash (Per Cent.).	Alkalinity of Ash.	CaO (Per Cent.).	Baier and Neumann Test.	Resocine Test.	Dealer.
32.0	0.55	17.6	0.158	Positive	Positive	Frank E. Webb, Springfield.
30.8	0.53	18.8	0.175	Positive	Positive	
31.6	0.55	17.6	0.158	Positive	Positive	M. A. Allen, Springfield.
30.8	0.60	15.2	0.150	Positive	Positive	Daniel A. Neylon, Springfield.
28.8	0.51	17.6	0.163	Positive	Positive	Columbia Creamery, Springfield.
31.2	–	24.0	0.215	–[1]	–	
13.0	–	–	–	Negative	Negative	

[1] Sour when received.

Foods exclusive of Milk.

The summary of analyses of food products may be found on page 473. Under the several headings only such facts as require special consideration will be discussed. There were 1,837 samples collected, of which 333 were adulterated.

Butter.

Sixty-eight samples were examined during the year, of which 12 samples were adulterated. These consisted of 5 samples of oleomargarine and 7 samples of renovated butter.

Canned Fish.

Four samples were obtained, 1 of which was found to be adulterated. This was a sample of sardine paste, put up by Crosse & Blackwell, and contained a boron preservative. A subsequent sample was found to be free from boron.

Canned Fruits and Vegetables.

Of the 23 samples examined, 1 was found to be adulterated. This was branded Omaha Brand Sweet Wrinkled Peas, and was found to be a can of soaked peas, not marked in conformity with the law.

Cheese.

Twenty-four samples were examined, 2 of which consisted of McLaren's Imperial cheese, containing borax, and were not marked in strict conformity with the law.

Cider.

Ten of the 38 samples obtained were adulterated. These samples contained antiseptic substances, principally benzoic acid, and were purchased by the inspectors in unmarked packages. The only adulterated sample which bore a label was from James Kinsley, West Acton, and was marked 0.1 per cent. sodium benzoate. This sample was found to be preserved with salicylic acid and to be free from benzoates.

Dried Fruits.

During the month of November 56 samples of dried fruits were examined, 33 of which were found to contain more or less sulphurous acid. The method of examination of these fruits was as follows: 25 grams of the sample were placed in a 500 cubic centimeter Kjeldahl flask, 100 cubic centimeters of water added and the sample allowed to soak for a few hours. It was then distilled with steam into N/10 iodine solution. After about 200 cubic centimeters of distillate were collected, the residual iodine was titrated with N/10 sodium thiosulphate.

This method is said to give high results, and the following experiments were made to determine if the error was excessive. A sample of dried apricots was passed through a meat chopper, and two portions of

25 grams each were weighed into separate flasks. These were distilled as described above, and only one was titrated. The excess of iodine was boiled out of the other distillate, barium chloride was added to each, and the resulting barium sulphate was weighed.

By titration, ...	0.1969 per cent. sulphur dioxide.
From barium sulphate from titrated solution, ...	0.1968 per cent. sulphur dioxide.
From barium sulphate from untitrated solution, ...	0.1961 per cent. sulphur dioxide.

The results obtained upon two samples of wine were as follows: —

Volumetric analysis, ...	0.0205 per cent. sulphur dioxide.
Gravimetric analysis, ...	0.0192 per cent. sulphur dioxide.
Volumetric analysis, ...	0.0246 per cent. sulphur dioxide.
Gravimetric analysis, ...	0.0209 per cent. sulphur dioxide.

It will be seen that there is no practical difference between the two methods.

The following table shows the summary of the analyses of the dried fruit samples: —

Sulphur Dioxide in Dried Fruits.

Character of Sample.	Number of Samples.	Number containing Sulphites.	Per Cent. SO_2.
Apricots, ...	10	10	0.08 to 0.27
Peaches, ...	13	13	0.05 to 0.14
Sultana raisins, ...	11	4	0.04 to 0.08
Prunes, ...	7	3	0.04 to 0.12
Plums, ...	1	1	0.08
Cherries, ...	1	1	0.02
Apples, ...	4	1	0.01
Orange peel, ...	1	-	-
Citron, ...	1	-	-
Raspberries, ...	1	-	-
Currants, ...	1	-	-
Peas, ...	4	-	-
Glacé fruits, ...	1	-	-
Totals, ...	58	33	0.01 to 0.27

Flavoring Extracts.

Sixty-three samples were examined, of which 9 were adulterated. These consisted of 4 samples of lemon extract, 2 of peppermint, 2 of vanilla and 1 of wintergreen. The 4 samples of adulterated lemon extract were nearly up to the required strength; the sample of wintergreen extract bore no name or brand, and contained 0.85 per cent. oil. One sample of peppermint extract labeled "Gilt Edge Brand, Portland, Me.," contained but 0.2 per cent. peppermint oil. The other peppermint sample was of the same composition, and was labeled "Hatch Extract Company, Wakefield." The sample of vanilla made by Lambert & Lowman, Detroit, was entirely artificial, and contained 0.15 per cent. each of vanillin and coumarin. A sample of vanilla from the C. H. Morse Manufacturing Company, Pawtucket, R. I., contained 0.08 per cent. coumarin and 0.08 per cent. vanillin.

Grape Juice.

Only 1 of the 17 samples was adulterated. This was labeled "Malto-Grapo, manufactured by the Malto-Grapo Company, Ltd., Paw Paw, Mich." This sample contained salicylic acid.

Jams and Jellies.

Eighty-two samples were examined, of which 4 were adulterated. One sample each of "Petit Maraschino Cherries," and preserved plums manufactured by the Williams Bros. Company, Detroit, and "Mohican" raspberry jam, were preserved with benzoic acid. A sample of strawberry preserves put out by the Twitchell-Champlin Company, Portland, Me., contained salicylic acid.

Lard.

Of 17 samples examined, only 1 was adulterated, this sample being the usual mixture of cotton-seed oil, beef and lard stearine.

Maple Sugar.

Forty-five samples were examined, of which 8 were adulterated. These were of the usual cane sugar, maple sugar mixture, the cane sugar being present to an extent of from 35 to 85 per cent.

Maple Syrup.

One sample of maple syrup, put up by Haskell Adams Company of Boston, was found to contain 90 per cent. cane sugar syrup. The other samples were either pure maple syrup or were properly labeled.

Meat Products.

Three hundred and sixty-two samples were examined, 295 of which were found to be pure or were labeled according to the statutes. The 67 adulterated samples consisted of 25 samples of hamburg steak which contained sodium sulphite and were not labeled, and 42 samples of sausages which were preserved with sodium sulphite or with borax.

Olive Oil.

Of 263 samples, 86 were adulterated, cotton-seed oil being used in all cases, the amount varying from 5 to 100 per cent. It was found that as a rule the cottonseed oil could be detected by the Halphen test. In one case cotton-seed oil was used which had apparently been heated, as it took prolonged treatment to produce the red color for the qualitative detection. For quantitative work the refractometer was found to be sufficient in most cases, and occasionally determinations of the iodine number were made. Nearly all these samples were obtained from Italians or Greeks, and in all cases it was more or less difficult to trace back to the responsible persons. Several cases were turned over to the United States Department of Agriculture, as they were found to be purchased, without knowledge of their adulterated character, from other States; and prosecutions have been instituted in the United States Courts in all of these cases. The following are the brands of adulterated olive oil: —

Olio Finissimo Re'd Italia Brand.
Olio D'Oliva G. Dr. Trapani Scicilia Italia.
Olio D'Oliva Piorissimo, Ditta R. Antinotti Produttore A Lucca, Genoa, Italy.
Absolutely Pure Imported Athens Olive Oil, P. Demoris, Newburyport, Mass.
Olio Soprafino Fracescani Brand, Prodotti Dr. Olii.
Olio D'oliva Sopraffino di Lucca.
Olio D'oliva Sopraffino Lucca Brand.
Olio Puro D'oliva garantito Torelli Brand.
Olio Finessimo di oliva vergine Re Ditalia Brand.
Olio Finessimo di oliva Gaetans Peluso Fui Pasquale.
Olio San Pietro Brand.
Compound Olive Oil and Cotton seed Oil, Traponi Brand.

Pickles.

Three samples of pickles were found adulterated, containing alum. These were obtained from the Lutz & Schraum Company, Allegheny, Pa., and Skilton, Foote & Co., Boston. The name and percentage of the preservative were not stated upon the label.

Proprietary Foods.

Thirty-one samples of proprietary foods were examined, of which 23 are reported as adulterated, representing 17 different brands of food, by reason of the fact that they contain alcohol. These consisted mostly of root beer extracts and proprietary alcoholic beverages. The following table gives the list of these adulterated brands of proprietary foods: —

List of Adulterated or Improperly Labeled Proprietary Foods.

Character of Sample.	Manufacturer or Wholesaler.	Result of Analysis.
Allen's Root Beer Extract, . .	Charles E. Carter, Lowell, Mass., . .	15.00 per cent. alcohol.
Bryant's Root Beer Extract, .	Michigan Drug Company, Detroit, Mich.,	4.56 per cent. alcohol.
Hire's Root Beer Extract, . .	Charles E. Hires Company, Philadelphia, Pa.	6.44 per cent. alcohol.
Indian Root Beer Extract, . .	Baker Extract Company, Springfield, Mass. and Portland, Me.	11.76 per cent. alcohol.
Larkin Root Beer Extract, . .	Larkin Company, Buffalo, N. Y., . .	11.15 per cent. alcohol.
Dr. Swett's Root Beer Extract, .	Dr. Swett Root Beer Extract Company, Boston, Mass.	10.92 per cent. alcohol.
Joyce's Superior Malt, . .	Charles H. Joyce, Lowell, Mass., . .	39.54 per cent. alcohol.
Wild Cherry Bounce, . . .	A. Bauer & Co., Chicago, Ill., . . .	16.41 per cent. alcohol.
Horehound, Rock and Rye,	S. F. Petts & Co., Boston, Mass., .	18.25 per cent. alcohol.
Horehound, Rock and Rye,	S. F. Petts & Co., Boston, Mass., .	17.72 per cent. alcohol.
Rock and Rye, . . .	S. F. Petts & Co., Boston, Mass., .	15.85 per cent. alcohol.
Petts' Rock, Rye, Horehound, Pineapple and Lemon.	S. F. Petts & Co., Boston, Mass., .	15.57 per cent. alcohol.
Rock, Rye and Lemon, . .	A. G. Marshnetz & Co., N. Y., . . .	29.70 per cent. alcohol.
Rock Candy and Rye Whiskey, .	Santa Clara Company, Boston, Mass., .	33.91 per cent. alcohol.
Roco-Ryo, ...	Charles L. Richardson & Co., Boston, Mass.	18.68 per cent. alcohol.
Roco-Ryo, ...	E. E. Gray Company, Boston, Mass., .	20.23 per cent. alcohol.
Tom and Jerry with Honey, .	New York Fruit Cordial Company, New York, N. Y.	11.59 per cent. alcohol.

Shrimps.

Two samples were examined, 1 of which was found to be preserved with borax.

Syrup.

Sixteen samples were examined, of which 5 were adulterated. These were fruit syrups containing preservatives. None of these 5 samples bore a label stating the manufacturer or the presence of the preservative.

Table Sauces.

Fifty-one samples were examined, of which 6 contained preservatives. The list of preserved samples is as follows: —

List of Adulterated Brands of Table Sauce.

Brand.	Manufacturer or Wholesaler.	Result of Analysis.
Griffon Catsup, ...	California Fruit Consumer's Association.	Preserved with benzoic acid; obscurely labeled.
Libby's Chili Sauce, . . .	Libby, McNeill & Libby, Chicago, Ill.	Preserved with benzoic acid.
New England Tomato Relish, .	Skilton, Foote & Co., Boston, .	Preserved with benzoic acid.
Nerver Pure Extract of Tomato, .	A. Bauer & Co., Inc., Chicago, Ill.,	Preserved with benzoic acid; contained 0.233 per cent. sodium benzoate.
Dillon's Home Made Style Catsup,	Thos. Dillon & Son, Auburn, R. I.,	Preserved with benzoic acid; marked 0.1 per cent., contained 0.2 per cent. of sodium benzoate.
Royal Oyster and Clam Sauce, .	Horton Cato Manufacturing Company, Detroit, Mich.	Preserved with benzoic acid; marked 0.1 per cent., contained 0.48 per cent. of sodium benzoate.

During the past few months of the year we have made a large number of quantitative determinations of benzoic acid in food products, with a view of seeing how accurately they were labeled. The method we have used is that of Edmund Clark (Science, Aug. 20, 1909, page 253), and is as follows: —

An aliquot portion of the filtrate, obtained by filtering a weighed amount of the substance which has been mixed with water and made up to a definite volume, is acidified with hydrochloric acid and shaken out with three 100 cubic centimeter portions of ether. The unwashed ether extract is distilled rapidly over steam or by electric stove to the volume of about 5 cubic centimeters, and the residue exhausted by a current of air. This extract is dissolved in a little alkaline water, and, after transferring to a Squibb separator and acidifying with hydrocholoric acid, is shaken out with 40, 30, 20 and 10 cubic centimeter successive portions of chloroform. The chloroform extract is washed with 30 cubic centimeters of water and transferred to a suitable container to which is added 100 cubic centimeters of recently boiled water and a few drops of phenol-phthalein.

The mixture is then titrated with N/10 NaOH (Clark uses N/20 alkali for titration), shaking well after each addition of alkali. Each cubic centimeter of N/10 alkali used has a benzoic acid value of .0122 and a sodium benzoate value of 0.0144. A correction is made for acidity of the chloroform.

We have found that as a rule the markings were correct. In a few cases the amounts of sodium benzoate were found to exceed the statement upon the label. In these cases duplicate determinations were made by the method of R. M. West. (Jour. of Ind. and Eng. Chem., Volume 1, page 190), which method consists in decomposing the substance with strong sulphuric acid, distilling with steam and titrating the distillate.

Determinations by the method of West gave 0.2 per cent. sodium benzoate and by the method of Clark 0.218 per cent. of sodium benzoate.

The following table shows the amount of sodium benzoate marked on the label, and the amount found by analysis in a few cases: —

Labelled (Per Cent.).	Found (Per Cent.).	Labelled (Per Cent.).	Found (Per Cent.).
0.1	0.233	0.2	0.093
0.1	0.218	0.1	0.080
0.1	0.200	0.1	0.070
0.1	0.098	0.1	0.030

Summary of Statistics of Foods exclusive of Milk.

	Genuine.	Adulterated.	Total.		Genuine.	Adulterated.	Total.
Baking powder,	6	1	7	Cream of tartar,	11	–	11
Butter,	56	12	68	Dried fruits,	23	33	56
Canned fish,	3	1	4	Flavoring extracts: —			
Canned fruits and vegetables,	22	1	23	Ginger,	1	–	1
Cheese,	20	2	22	Lemon,	12	4	16
Cider,	28	10	38	Orange,	3	–	3
Clams and oysters,	10	–	10	Peppermint,	1	2	3
Cocoa and chocolate,	23	–	23	Vanilla,	27	2	29
Coffee,	8	–	8	Wintergreen,	–	1	1
Condensed milk,	26	–	26	Grape juice,	16	1	17
Confectionery,	18	–	18	Honey,	27	–	27
Cream,	164	7	171	Horseradish,	6	–	6

Summary of Statistics of Foods exclusive of Milk — Concluded.

	Genuine.	Adulterated.	Total.		Genuine.	Adulterated.	Total.
Ice cream,	2	–	2	Meat products — *Con.*			
Jams and jellies,	78	4	82	Tripe,	8	–	8
Lard,	16	1	17	Nonalcoholic drinks,	16	–	16
Malt liquor: —				Noodles,	2	–	2
Ale,	9	–	9	Olive oil,	177	86	263
Beer,	4	–	4	Pastry,	6	–	6
Malt extract,	6	–	6	Pickles,	25	3	28
Porter,	1	–	1	Potato flour,	1	–	1
Maple sugar,	37	8	45	Proprietary foods,	8	23	31
Maple syrup,	12	1	13	Salad dressing,	9	–	9
Meat products: —				Salad oil,	2	–	2
Beef extract,	2	–	2	Shellfish,	4	–	4
Canned meat,	22	–	22	Shrimps,	1	1	2
Hamburg steak,	51	25	76	Spices,	71	–	71
Head cheese,	5	–	5	Syrup,	11	5	16
Lambs' tongues,	5	–	5	Table sauce,	45	6	51
Mince meat,	10	–	10	Vinegar,	152	51	203
Pigs' feet,	4	–	4	Wine,	3	–	3
Pressed meat,	12	–	12	Totals,	1,504	333	1,837
Sausages,	176	42	218				

Drugs.

During the year 889 samples of drugs have been examined. The character and quality of these are shown in the table on page 478. Only such drugs as need special comment will be discussed.

Alcohol.

Of 42 samples examined, only 2 were below the required strength. One of these contained 75.85 per cent. alcohol by volume, the other contained 48.98 per cent. alcohol by volume.

Cocaine Hydrocloride.

The samples examined were reported as adulterated, not on account of inferiority, but because they were sold in violation of the law, without a physician's prescription.

Extract of Licorice.

Six samples of extract of licorice were collected during the year, 2 of which contained about 25 per cent. cornstarch.

Camphorated Oil.

An improvement in the quality of the camphor liniment or camphorated oil upon the market was noted this year. Only 3 of the 26 samples examined were below the required strength. Two of these samples contained 16 per cent. camphor; the other contained 18 per cent. of camphor. Camphor liniment should contain 20 per cent. of camphor.

Lime Water.

The single sample examined was about two-thirds the strength required by the United States Pharmacopœia.

Expressed Oil of Almonds.

Eight samples were examined, of which 2 were declared adulterated. One of these samples was mixed with apricot kernel oil; the other was adulterated with olive oil.

Olive Oil.

Of 76 samples examined, 69 proved to be pure. The other 7 samples were mixed with more or less cotton-seed oil, and in two cases consisted entirely of cotton-seed oil.

Proprietary Medicines.

Ninety-two samples were examined, of which 19 did not conform to the law. These consisted of 1 cocaine preparation, 4 headache or cold preparations containing acetanilid, and 14 drugs containing alcohol. The following table gives the name of the drug, the label and result of analysis: —

Name.	Label.	Result of Analysis.
Az-Ma-Syde, ...	Asthma Remedy and Manufacturing Company, Boston, Mass.	Contained cocaine.
Caffanalid Headache Powders,	George H. Hill, Ayer, Mass., . .	Improperly labeled.
Franklin Brand Wild Cherry and Pepsin.	- -	Alcohol 11.79 per cent. by volume.
Dr. Holbrook's Kola Powders,	Holbrook Kola Company, Boston, Mass.	Improperly labeled.
Bok's Cold Tablets, . .	Pierson Drug Company, Boston, Mass.	Contained acetanilid.
Chionia, ...	Peacock Chemical Company, St. Louis, Mo.	Alcohol 18 per cent. by volume.
Goff's Cough Cure, . .	S. B. Goff & Sons Company, Camden, N. J.	Alcohol 8.52 per cent. by volume.
Alaska Catarrh Compound, .	Alaska Compound Company, Lynn, Mass.	Alcohol 9.42 per cent. by volume.
Remedy for Dyspepsia and Heartburn.	S. Grover Graham Company, Newburgh, N. Y.	Alcohol 6.00 per cent. by volume.
Bardwell's Q. R., . . .	J. C. Bardwell, Worcester, Mass., .	Alcohol 7.63 per cent. by volume.
Pain Vanquisher, . . .	Standard Soap Works, Boston, Mass.	Alcohol 84.76 per cent. by volume.
Helmbold's Concentrated Compound Sarsaparilla.	- -	Alcohol 2.31 per cent. by volume.
Prof. Penny's Body Regulator,	- -	Alcohol 5.91 per cent. by volume.
White Pine Expectorant with tar.	Geo. A. Miller, Cambridge, Mass., .	Alcohol not marked correctly.
Elixir DeRiga, . . .	M. Stradowsky, ...	Alcohol 37.2 per cent. by volume.
Blood Wine Tonic and Alterative.	Cushing Medical Supply Company, Boston, Mass.	Alcohol 20.13 per cent. by volume.
Dr. Wilson's Wine of Cod Liver Oil.	Walker-Rintels Drug Company, Boston, Mass.	Alcohol 12.5 per cent. by volume.
Stearns' Wine of Cod Liver Oil with Peptonate of Iron.	Frederick Stearns & Co., Detroit, Mich.	Alcohol 20.3 per cent. by volume.

Borax.

Nine samples were examined, 2 of which were adulterated. These two samples were marked Crescent Brand Borax, Chas. L. Hirsh & Co., New York, N. Y.

Spirit of Nitrous Ether.

All 4 samples examined were of low strength. The percentage of nitrous ether varied from 0.68 per cent. to 2.25 per cent. The full-strength preparation should contain 4 per cent. of nitrous ether.

Spirit of Anise.

Forty-nine samples were examined, 23 of which were deficient in anise oil. The following method has been used for the determination of anise oil: place 10 cubic centimeters of the sample in the Babcock milk bottle. Add 20 cubic centimeters saturated salt solution, shake thoroughly, add water up to the neck and shake again. Fill the neck with water, shake once more, place the bottle in the centrifuge and whirl for about ten minutes. The reading of the separated oil, multiplied by 2.1, will give the amount of oil in the sample.

Spirit of Peppermint.

Of the 69 samples examined, 47 contained 10 per cent. of oil and 22 contained less than 10 per cent. of oil. The method of estimating the oil is the same as that described under spirit of anise.

Tincture of Iodine.

Of 156 samples examined, 23 were below the requirements of the Pharmacopœia, being deficient in iodine. In many of these poor samples the deficiency from the standard was merely technical, and not sufficient to institute any complaint.

Tincture of Ginger.

Thirty-four samples were examined, of which 6 did not conform to the pharmacopœial requirements, being made with diluted alcohol instead of strong alcohol.

Mercurial Ointment.

Ninety-six samples of mercurial ointment were collected during the year, and 50 of these were found to contain 50 per cent. of mercury, as required by the Pharmacopœia. Forty-six of these samples fell below the pharmacopœial requirements, many of them being the dilute mercurial ointment, which contains one-third mercury. Twenty-eight samples contained less than one-third mercury, the percentage of mercury varying from 9 to 28 per cent.

Iodine Ointment.

Four samples were examined, 3 of which were found to be pure. The fourth sample was low in iodine. It was found from experiments made in the laboratory that iodine ointment will deteriorate very rapidly, and for this reason no further collections were made.

Zinc Oxide Ointment.

Eleven samples were collected, 5 of which were deficient in zinc oxide, varying in these samples from 10 to 18 per cent. The Pharmacopœia requires zinc ointment to contain 20 per cent. of zinc oxide. In making analyses of zinc ointment, two grams of the sample were weighed into a porcelain crucible and burned. The residual zinc oxide was then weighed. Experiments on zinc ointment made in the laboratory show that this method gives correct results.

Summary of Statistics of Drugs.

	Genuine.	Adulterated.	Totals.		Genuine.	Adulterated.	Totals.
Alcohol,	40	2	42	Quininae sulphas,	20	–	20
Aqua hamamelidis,	23	–	23	Sodii boras,	7	2	9
Aqua hydrogenii dioxidi,	1	–	1	Sodii phosphas,	4	–	4
Cera flava,	2	–	2	Spiritus ætheris nitrosi,	–	4	4
Cocainæ hydrochloras,	–	2	2	Spiritus anisi,	26	23	49
Extractum glycyrrhizæ,	4	2	6	Spiritus camphoræ,	53	10	63
Gin,	2	–	2	Spiritus menthæ piperitæ,	47	22	69
Glycerinum,	45	–	45	Spiritus myrciæ,	6	–	6
Linimentum camphoræ,	23	3	26	Spiritus vini gallici,	1	–	1
Liquor calcis,	–	1	1	Syrupus,	–	1	1
Liquor magnesii citratis,	11	–	11	Tinctura arnicæ,	1	–	1
Magnesii sulphas,	1	–	1	Tinctura iodi,	133	23	156
Oleum amygdale expressum,	6	2	8	Tinctura opii camphorata,	1	–	1
Oleum limonis,	2	–	2	Tinctura zingiberis,	28	6	34
Oleum morrhuæ,	6	–	6	Unguentum hydrargyri,	50	46	96
Oleum olivæ,	69	7	76	Unguentum iodi,	3	1	4
Oleum ricini,	10	–	10	Unguentum zinci oxidi,	6	5	11
Proprietary medicines,	73	19	92	Total,	708	181	889
Pulvis glycyrrhizæ compositus.	4	–	4				

Inspection of Liquors.

The police department of 33 cities and towns have sent in 200 samples of liquor for examination, of which 117 contained more than 1 per cent. of alcohol, and 83 contained less than 1 per cent. of alcohol. The following table gives the number and character of the samples obtained from different localities: —

Summary of Liquor Statistics.

Cities and Towns.	Beer.	Cider.	Wine.	Whiskey.	Ale.	Gin.	Rum.	Miscellaneous.
Beverly,	–	1	–	–	–	–	–	
Boston,	8	–	–	1	–	–	–	Whiskey and syrup.
Carver,	–	–	–	–	–	–	–	Beef, iron and wine.
Fall River,	52	4	2	–	–	1	–	Cherry juice.
Fitchburg,	–	–	1	–	–	–	–	
Franklin,	1	–	–	–	–	–	–	
Gloucester,	4	–	–	–	–	–	–	1, unknown; 2, mixed liquors.
Great Barrington,	–	–	–	–	1	–	–	
Haverhill,	3	–	–	–	–	–	–	
Hinsdale,	1	–	–	1	–	–	–	
Hudson,	–	–	–	–	–	–	–	1, mixed liquor; 1, sulphonaphthol.
Hyde Park,	–	–	1	–	–	–	–	
Lee,	2	–	–	–	–	–	–	
Lunenburg,	–	–	–	–	1	–	–	
Lynn,	3	3	4	1	–	–	–	Water (high in alcohol).
Marlborough,	–	4	–	9	–	1	1	1, mixed liquor; 1, cough medicine.
Maynard,	–	1	–	–	–	–	–	
Melrose,	–	3	–	–	–	–	–	
Millbury,	–	2	–	–	–	–	–	
Nantucket,	–	–	1	–	–	–	–	3, cologne.
Natick,	–	1	–	7	–	–	–	
New Bedford,	15	–	–	–	–	–	–	
Newton,	–	–	1	–	–	1	–	Jamaica ginger.
Norwood,	–	–	7	2	–	–	–	2, mixed liquors.
Quincy,	1	1	–	–	–	–	–	
Reading,	–	2	–	–	–	–	–	
Revere,	3	–	–	–	–	–	–	
Stoughton,	–	–	1	2	–	–	–	
Swampscott,	–	–	1	–	–	–	–	
Taunton,	–	–	1	–	–	–	–	
Templeton,	5	–	–	–	–	–	–	
Waltham,	2	–	–	–	–	–	–	
Weymouth,	4	–	8	–	–	–	–	
Totals,	104	22	28	23	2	3	1	17

The mixed liquors consisted generally of whiskey mixed with water, sulphonaphthol and tea, taken from sinks, sink traps and pitchers. In some cases these were obtained from interstate express companies, as in Gloucester, Hudson and Marlborough. One sample from Lynn, marked "water," contained 1.2 per cent. of alcohol.

The attendance of the analyst has been required in the lower court in Barnstable, Boston, Concord, Fall River, Fitchburg, Gloucester, Hudson, Lynn, Marlborough, New Bedford, Quincy, Stoughton and Taunton; in the superior court of Worcester, Norfolk, Essex and Middlesex counties.

General Summary.

	Genuine.	Adulterated.	Total.
Milk,	3,584	1,027	4,611
Foods, exclusive of milk,	1,504	333	1,837
Drugs,	708	181	889
Liquors,	83	117[1]	200
Totals,[1]	5,879	1,658	7,537

[1] These 117 samples of liquor are reported adulterated by reason of the fact that they were sold illegally and contained more than 1 per cent. of alcohol.

Respectfully submitted,

HERMANN C. LYTHGOE.

INSPECTION OF DAIRIES.

By the Secretary of the Board.

INSPECTION OF DAIRIES.

During the year ended Nov. 30, 1909, 1,771 dairies were examined by the veterinarian of the Board, and the attention of the boards of health of the cities and towns wherein the dairies were situated or the product thereof sold was called to a total of 3,375 objectionable conditions. As in former years, suggestions were made as to changes regarded as necessary in the interest of a wholesome supply and of the public health.

Of the total number of dairies examined, 1,439 were situated in Massachusetts and 332 in neighboring States. The extra-state dairies were visited because of the fact that their product is marketed in this Commonwealth, and, if found to be other than the fresh, clean product of healthy cows, is, under the standards fixed in accordance with the provisions of the national law relative to food and drugs, to be deemed to be adulterated, and hence may not enter into interstate commerce.

The following table shows the number of dairies examined in the cities and towns visited, and the percentage found in each place to be commendable: —

Inspection of Dairies, 1909.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Belchertown,	5	3	2	40.00
Second inspection,	7	2	5	71.43
Billerica,	2	–	2	100.00
Second inspection,	35	12	23	65.71
Boxford,	2	1	1	50.00
Second inspection,	11	3	8	72.73
Chelmsford,	1	–	1	100.00
Second inspection,	50	22	28	56.00
Dalton,	1	–	1	100.00
Second inspection,	8	5	3	37.50
Danvers,	9	5	4	44.44
Second inspection,	40	12	28	70.00
Dracut,	12	10	2	16.67
Second inspection,	40	28	12	30.00

Inspection of Dairies, 1909 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Framingham,	21	3	18	85.71
Second inspection,	27	3	24	88.89
Gardner,	8	1	7	87.50
Second inspection,	19	8	11	57.89
Gloucester,	22	10	12	54.55
Second inspection,	50	20	30	60.00
Granby,	4	3	1	25.00
Second inspection,	55	32	23	41.82
Third inspection,	2	–	2	100.00
Groton,	4	1	3	75.00
Second inspection,	22	13	9	40.91
Hamilton,	–	–	–	–
Second inspection,	9	2	7	77.78
Third inspection,	2	–	2	100.00
Harvard,	14	11	3	21.43
Second inspection,	82	55	27	32.93
Holyoke,	3	1	2	66.67
Second inspection,	28	20	8	28.57
Hubbardston,	12	10	2	16.67
Second inspection,	21	11	10	47.62
Ipswich,	5	1	4	80.00
Second inspection,	35	21	14	40.00
Lancaster,	–	–	–	–
Second inspection,	14	3	11	78.57
Lanesborough,	14	13	1	7.14
Second inspection,	7	6	1	14.29
Lowell,	1	–	1	100.00
Second inspection,	14	9	5	35.71
Malden,	1	1	–	–
Second inspection,	6	5	1	16.67
Fourth inspection,	8	7	1	12.50
Medford,	4	2	2	50.00
Second inspection,	11	3	8	72.73
Third inspection,	1	–	1	100.00
Middleton,	–	–	–	–
Second inspection,	11	2	9	81.82

Inspection of Dairies, 1909 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Nantucket,	40	30	10	25.00
North Reading,	3	3	–	–
Second inspection,	21	5	16	76.19
Third inspection,	2	1	1	50.00
Peabody,	1	–	1	100.00
Second inspection,	16	2	14	87.50
Pepperell,	5	2	3	60.00
Second inspection,	23	9	14	60.87
Pittsfield,	14	14	–	–
Second inspection,	23	19	4	17.39
Princeton,	2	2	–	–
Second inspection,	16	7	9	56.25
Provincetown,	10	8	2	20.00
Reading,	2	1	1	50.00
Second inspection,	15	2	13	86.67
Rockport,	11	6	5	45.45
Second inspection,	11	5	6	54.55
Sandwich,	20	10	10	50.00
Southampton,	23	20	3	13.04
South Hadley,	6	5	1	16.67
Second inspection,	46	30	16	34.78
Southwick,	15	9	6	40.00
Second inspection,	12	9	3	25.00
Tewksbury,	5	–	5	100.00
Second inspection,	27	12	15	55.56
Topsfield,	–	–	–	–
Second inspection,	23	11	12	52.17
Townsend,	4	4	–	–
Second inspection,	11	1	10	90.91
Truro,	15	6	9	60.00
Tyngsborough,	6	4	2	33.33
Second inspection,	3	–	3	100.00
Wenham,	2	–	2	100.00
Second inspection,	19	8	11	57.89
Third inspection,	4	2	2	50.00

Inspection of Dairies, 1909 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Westfield,	32	28	4	12.50
Second inspection,	24	15	9	37.50
Westford,	18	10	8	44.44
Second inspection,	47	15	32	68.09
Third inspection,	1	1	–	–
Miscellaneous,	101	62	39	38.61
Ashford, Conn.,	–	–	–	–
Second inspection,	4	3	1	25.00
Brooklyn, Conn.,	–	–	–	–
Second inspection,	3	3	–	–
Chaplin, Conn.,	–	–	–	–
Second inspection,	14	4	10	71.43
Columbia, Conn.,	–	–	–	–
Second inspection,	3	1	2	66.67
Coventry, Conn.,	2	1	1	50.00
Second inspection,	7	2	5	71.43
Eastford, Conn.,	–	–	–	–
Second inspection,	7	2	5	71.43
Hampton, Conn.,	–	–	–	–
Second inspection,	20	17	3	15.00
Lebanon, Conn.,	–	–	–	–
Second inspection,	1	–	1	100.00
Mansfield, Conn.,	–	–	–	–
Second inspection,	9	4	5	55.56
Pomfret, Conn.,	–	–	–	–
Second inspection,	17	13	4	23.53
Scotland, Conn.,	–	–	–	–
Second inspection,	3	3	–	–
Windham, Conn.,	–	–	–	–
Second inspection,	2	1	1	50.00
Antrim, N. H.,	2	1	1	50.00
Second inspection,	12	8	4	33.33
Bennington, N. H.,	–	–	–	–
Second inspection,	2	–	2	100.00
Chester, N. H.,	–	–	–	–
Second inspection,	1	1	–	–

Inspection of Dairies, 1909 — Continued.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Deering, N. H.,	-	-	-	-
Second inspection,	1	1	-	-
Derry, N. H.,	-	-	-	-
Second inspection,	8	4	4	50.00
Third inspection,	1	-	1	100.00
Francestown, N. H.,	-	-	-	-
Second inspection,	1	1	-	-
Greenfield, N. H.,	2	1	1	50.00
Second inspection,	27	19	8	29.63
Hancock, N. H.,	-	-	-	-
Second inspection,	19	10	9	47.37
Hillsborough, N. H.,	-	-	-	-
Second inspection,	7	1	6	85.71
Hudson, N. H.,	-	-	-	-
Second inspection,	6	1	5	83.33
Jaffrey, N. H.,	-	-	-	-
Second inspection,	6	3	3	50.00
Londonderry, N. H.,	-	-	-	-
Second inspection,	12	6	6	50.00
Pelham, N. H.,	-	-	-	-
Second inspection,	1	-	1	100.00
Peterborough, N. H.,	-	-	-	-
Second inspection,	12	2	10	83.33
Windham, N. H.,	-	-	-	-
Second inspection,	4	2	2	50.00
Little Compton, R. I.,	4	2	2	50.00
Second inspection,	18	2	16	88.89
Portsmouth, R. I.,	1	-	1	100.00
Second inspection,	5	-	5	100.00
Tiverton, R. I.,	6	4	2	33.33
Second inspection,	22	6	16	72.73
Barnet, Vt.,	-	-	-	-
Second inspection,	3	1	2	66.67
Barton, Vt.,	-	-	-	-
Second inspection,	4	1	3	75.00

Inspection of Dairies, 1909 — Concluded.

City or Town.	Total Number of Dairies examined.	Number of Dairies where One or More Objectionable Features were observed.	Number of Dairies found to be without Objectionable Feature.	Per Cent. Clean Dairies.
Burke, Vt.,	-	-	-	-
Second inspection,	4	2	2	50.00
Coventry, Vt.,	-	-	-	-
Second inspection,	6	3	3	50.00
Lyndon, Vt.,	-	-	-	-
Second inspection,	6	4	2	33.33
Lyndonville, Vt.,	-	-	-	-
Second inspection,	3	1	2	66.67
Putney, Vt.,	-	-	-	-
Second inspection,	14	4	10	71.43
St. Johnsbury, Vt.,	-	-	-	-
Second inspection,	2	1	1	50.00
Sutton, Vt.,	-	-	-	-
Second inspection,	8	7	1	12.50
Westminster, Vt.,	4	2	2	50.00
Second inspection,	6	4	2	33.33
Outside dairies,	332	159	173	52.11
Total Massachusetts dairies,	1,439	758	681	47.32
Total dairies,	1,771	917	854	48.22

Under "Miscellaneous" are included dairies situated in the following places, in no one of which were more than 8 inspected, the examinations having been made for some special reason, and not as a part of a general investigation: —

Acton.
Andover.
Beverly.
Cheshire.
Chicopee.
Clinton.
Dighton.
Dunstable.
Eastham.
Edgartown.
Everett.
Hinsdale.
Lenox.
Littleton.
Ludlow.
Marblehead.
Melrose.
Northampton.
Oak Bluffs.
Orleans.
Richmond.
Saugus.
Sudbury.
Washington.
Watertown.
West Tisbury.
Winchester.
Worcester.

Nature of the Defects to which Attention was called.

Below is presented an analysis of the 3,375 objectionable conditions to which the attention of boards of health was called: —

	Defects.	
Condition of Cows.		
Herds with tuberculosis,	2	
Unclean herds,	234	
		236
Condition of Barns.		
Dairy unfit for milk production,	19	
Building unfit for cows,	3	
Tie-up floor in need of repairing,	21	
Tie-up in need of new floor,	2	
		45
Light.		
Insufficient number of windows,	105	
Windows inadequate in size,	47	
		152
Ventilation.		
Additional ventilation needed,	3	
Barn overcrowded,	23	
		26
General Cleanliness.		
General uncleanliness of premises,	462	
Tie-up in need of cleaning and whitewashing,	596	
Accumulated manure,	33	
Manure piled back of cows,	13	
Horse manure used as bedding for cows,	26	
Sand used as bedding for cows,	8	
Cobwebs,	209	
Privy in barn,	14	
Slaughtering in vicinity of cows,	4	
Slaughtering in vicinity of milk room,	1	
Lack of proper drainage,	12	
Unclean cellar,	3	
Horses not separated from cows,	27	
Pigs kept near cows,	44	
Swill kept near cows,	3	
Brewers' grains in vicinity of cows,	2	
Poultry in cow tie-up,	3	
Decomposing vegetables in barn,	1	
Cows kept in barn cellar,	14	
		1,475

Condition of Cow Yards.

	Defects.	
Yard in need of proper drainage,	133	
General uncleanliness,	129	
Pools of stagnant water in yard,	13	
Liquid manure in yard,	6	
Decomposing vegetables in yard,	3	
Bones in yard,	1	
Swill in yard,	2	
		287

Water Supplies.

Well exposed to surface drainage,	20	
		20

Milk Rooms.

Milk room needed,	221	
Unclean milk room,	31	
Milk room unused,	13	
Milk room used for general storage,	4	
Milk room used for sleeping purposes,	1	
Unclean harness room used as a milk room,	1	
Milk room floor in need of repair,	1	
Milk room walls in need of repair,	1	
Milk room walls in need of whitewashing,	1	
Milk room in need of ventilation,	1	
		275

Care of Milk and Milk Utensils.

Milk cooled: —		
(*a*) On barn floor,	13	
(*b*) In unclean trough,	4	
(*c*) In well,	1	
(*d*) In barnyard,	8	
(*e*) In unclean shed,	7	
(*f*) In box in brook,	2	
(*g*) In vicinity of privy,	2	
(*h*) In unclean house cellar,	1	
(*i*) In barn cellar,	1	
(*j*) In vicinity of horses,	2	
(*k*) In wagon shed,	2	
(*l*) In drinking trough,	7	
(*m*) In harness room,	1	
(*n*) Back of cows,	5	
		56

			Defects.	
Milk handled: —				
(*a*) On barn floor,	477			
(*b*) Near horses,	3			
(*c*) Back of cows,	96			
(*d*) In general storage room,	3			
(*e*) In barnyard,	3			
(*f*) In grain room,	4			
(*g*) In kitchen,	7			
(*h*) In house cellar,	3			
(*i*) In unclean shed,	4			
(*j*) In wagon shed,	2			
	——	602		
Milk stored: —				
(*a*) On barn floor,	16			
(*b*) In drinking trough,	7			
(*c*) In unclean shed,	4			
(*d*) In wagon shed,	3			
(*e*) In barn cellar,	1			
(*f*) In vicinity of privy,	1			
(*g*) In harness room,	1			
(*h*) In barnyard,	6			
(*i*) In box used for general cooling purposes,	1			
(*j*) In box in brook,	1			
(*k*) Back of cows,	5			
(*l*) Near horses,	1			
	——	47		
Unclean water in cooling trough,		10		
Mixer kept in cow tie-up,		3		
Cans kept in barn,		137		
Cans washed in house kitchen,		1		
Cans washed in unclean shed,		1		
Provisions kept in refrigerator with milk,		1		
Milk bottles kept on barn floor,		1		
		——	859	
Total number of objectionable features,			3,375	

INSPECTION OF SLAUGHTERHOUSES.

SLAUGHTERHOUSES.

NUMBER OF ANIMALS SLAUGHTERED PER YEAR (APPROXIMATE).

District 1.

Barnstable,	619	
Chatham,	105	
Chilmark,	230	
Eastham,	67	
Falmouth,	492	
Harwich,	182	
Nantucket,	675	
Provincetown,	160	
Tisbury,	100	
Wareham,	227	
		2,857

District 2.

Acushnet,	750	
Berkley,	250	
Dartmouth,	2,500	
Dighton,	1,900	
Fairhaven,	500	
Fall River,	3,000	
Freetown,	550	
Marion,	300	
Mattapoisett,	300	
New Bedford,	2,750	
Rehoboth,	4,300	
Rochester,	500	
Seekonk,	2,100	
Somerset,	300	
Swansea,	3,300	
Westport,	1,750	
		25,050

District 3.

Abington,	243	
Bridgewater,	305	
Brockton,	550	
Carver,	73	
Cohasset,	40	

Duxbury,	112	
East Bridgewater,	383	
Halifax,	165	
Hanover,	100	
Hanson,	150	
Hingham,	135	
Kingston,	107	
Lakeville,	63	
Marshfield,	128	
Middleborough,	180	
Norwell,	155	
Pembroke,	60	
Plymouth,	214	
Plympton,	61	
Rockland,	125	
Scituate,	152	
West Bridgewater,	1,120	
Weymouth,	450	
Whitman,	260	
		5,331

District 4.

Attleborough,	940	
Avon,	250	
Braintree,	580	
Canton,	70	
Easton,	725	
Foxborough,	262	
Franklin,	245	
Holbrook,	200	
Mansfield,	426	
Milton,	125	
North Attleborough,	240	
Norton,	250	
Randolph,	375	
Raynham,	415	
Stoughton,	125	
Taunton,	1,215	
Walpole,	220	
Westwood,	130	
Wrentham,	50	
		6,843

District 5.

During the year 1908, the number of animals slaughtered at the Brighton Abattoir, the only slaughtering establishment in District 5, was . . . 107,644

District 6.

Cambridge,	37,250	
Reading,	3,270	
Somerville,	1,820,190	
Stoneham,	160	
Melrose,	202	
		[1]1,861,072

District 7.

Lynn,	716	
Peabody,	1,923	
Gloucester,	563	
Wenham,	1,200	
Ipswich,	761	
Beverly,	250	
Danvers,	631	
Topsfield,	3,620	
Lynnfield,	60 to 80	
		[1]9,724

District 8.

Newburyport,	2,400	
Newbury,	700	
Salisbury,	150	
Amesbury,	700	
West Newbury,	4,700	
Georgetown,	150	
Boxford,	3,000	
Haverhill,	12,000	
Lawrence,	4,000	
Methuen,	4,500	
Andover,	500	
Rowley,	700	
		33,500

District 9.

Acton,	1,422	
Arlington,	3,000	
Billerica,	691	
Burlington,	75	
Carlisle,	514	
Chelmsford,	3,809	
Concord,	10,920	
Dracut,	2,565	
Dunstable,	75	
Groton,	275	

[1] 1908.

Harvard,	1,340	
Lexington,	2,762	
Lincoln,	600	
Littleton,	40	
Lowell,	145	
Maynard,	450	
Pepperell,	475	
Shirley,	90	
Tewksbury,	296	
Townsend,	375	
Tyngsborough,	100	
Westford,	1,285	
Wilmington,	1,665	
Woburn,	1,075	
		34,044
District 10.[1]		
Watertown,	7,900	
		7,900
District 11.		
Worcester,	3,952	
Auburn,	100	
Brookfield,	900	
Charlton,	350	
Leicester,	300	
North Brookfield,	150	
Southbridge,	200	
Spencer,	500	
Uxbridge,	100	
		6,552
District 12.		
Athol,	600	
Ashburnham,	300	
Ashby,	500	
Barre,	400	
Boylston,	450	
Clinton,	700	
Dana,	200	
Gardner,	300	
Holden,	250	
Hubbardston,	400	
Lancaster,	300	
Leominster,	1,700	
Lunenburg,	800	
Oakham,	250	

[1] An occasional cow or calf slaughtered during cold weather in the other slaughterhouses in this district.

Princeton,	800	
Sterling,	300	
Templeton,	400	
Westminster,	400	
Winchendon,	500	
Fitchburg,	1,000	
		10,550

District 13.[1]

Ashfield,	900	
Belchertown,	600	
Charlemont,	365	
Chesterfield,	300	
Colrain,	1,300	
Cummington,	400	
Easthampton,	446	
Enfield,	2,000	
Erving,	30	
Gill,	225	
Goshen,	105	
Granby,	825	
Greenfield,	2,000	
Hadley,	2,600	
Hatfield,	300	
Hawley,	115	
Leverett,	250	
Leyden,	200	
Monroe,	100	
Montague,	537	
Northampton,	900	
Northfield,	1,200	
Orange,	427	
Pelham,	145	
Prescott,	15	
Rowe,	100	
Shelburne,	1,000	
Shutesbury,	80	
Southampton,	300	
Ware,	327	
Warwick,	75	
Wendell,	200	
Whately,	500	
Williamsburg,	300	
		19,167

[1] The following towns have failed to furnish an estimate of the number of animals slaughtered therein per year: Amherst, Bernardston, Buckland, Conway, Deerfield, Greenwich, Heath, New Salem, Plainfield, Sunderland and Westhampton.

District 14.

Wilbraham,	924	
Agawam,	150	
Blandford,	150	
Brimfield,	150	
Chester,	200	
East Longmeadow,	500	
Granville,	200	
Huntington,	300	
Holland,	33	
Longmeadow,	100	
Middlefield,	175	
Monson,	100	
Montgomery,	200	
Springfield,	600	
Southwick,	150	
Westfield,	500	
Holyoke,	296	
Chicopee,	160,700	
Ludlow,	1,000	
Hampden,	100	
Palmer,	700	
Russell,	300	
Tolland,	150	
Wales,	75	
West Springfield,	100	
Worthington,	600	
		168,453

District 15.

Adams,	10
Becket,	20
Cheshire,	246
Dalton,	16
Egremont,	500
Great Barrington,	760
Hinsdale,	81
Lanesborough,	75
Lee,	209
Lenox,	900
Monterey,	225
New Marlborough,	50
North Adams,	900
Otis,	200
Pittsfield,	750
Sandisfield,	283

Sheffield,	100	
Stockbridge,	450	
Washington,	410	
West Stockbridge,	140	
Williamstown,	5,000	
Windsor,	100	
		11,425
Total slaughtering per year,		2,308,212

EXAMINATION OF PLUMBERS.

EXAMINATION OF PLUMBERS.

State Board of Health, Commonwealth of Massachusetts.

Gentlemen:—In accordance with section 3, chapter 536, Acts of 1909, the State Examiners of Plumbers respectfully submit the following statement of their affairs from date of organization, July 31, 1909, to and including Nov. 30, 1909.

Organization.

James C. Coffey, Worcester, *Chairman.*
Charles R. Felton, Brockton.
Edward C. Kelly, Boston, *Clerk.*

Meetings were held weekly on Saturday at office of the clerk, 195 Centre Street, Boston.

Schedule of Examinations for 1909–10.

11 at Boston, State House, first Saturday of each month except August.
2 at Springfield, Technical High School, third Saturday of September and February.
2 at Fall River, City Hall, third Saturday of October and March.
2 at Worcester, City Hall, third Saturday of November and April.
2 at Lowell, City Hall, third Saturday of December and May.
2 at Pittsfield, City Hall, third Saturday of January and June.

Examinations.	Examined.	Passed.	Refused.
Boston, September 4,	36	10	26
Springfield, September 18,	22	7	15
Boston, October 2,	40	11	29
Fall River, October 16,	21	5	16
Boston, November 6,	33	12	21
Worcester, November 20,	11	–	11
Totals,	163	45	118

Registrations.	Masters.	Journeymen.
October,	91	194
November,	137	284
Totals,	228	478

Meetings,	26	Examinations,	6

Fees Received.	Paid to Treasurer of the Commonwealth.
163 examination license fees, at $0.50,	$81 50
228 master's licenses, at $2,	456 00
478 journeyman's licenses, at $0.50,	239 00
Total,	$776 50

For carrying out the Provisions of the Act relative to the Supervision of the Business of Plumbing, Chapter 536 of the Acts of 1909.

Appropriation, June 15–Nov. 30, 1909,	$1,600 00
Salary, clerk,	$720 43
Travelling expenses,	154 95
Express charges,	11 74
Printing,	86 69
Postage,	62 00
Books and stationery,	111 90
Plumbers' materials,	113 81
Cleaning,	6 25
Extra services,	21 15
Office supplies,	46 50
Wages, second and third examiners,	255 00
Miscellaneous,	2 27
Total,	$1,592 69

REPORT

UPON THE

Production and Distribution of Diphtheria Anti-toxin and Vaccine Virus

FOR THE

Year ended November 30, 1909.

REPORT

UPON THE

Production and Distribution of Diphtheria Antitoxin and Vaccine Virus

FOR THE

Year ended November 30, 1909.

The production of diphtheria antitoxin and vaccine has continued under the direction of Dr. Theobald Smith, at the laboratory of the State Board of Health, at Forest Hills. The distribution has been conducted, as before, at the office of the Board.

The total number of packages issued by the Board during the fourteen years and eight months ended Nov. 30, 1909, was as follows: —

	Bottles.
In 1895–1896 (year ended March 31),	1,724
In 1896–1897 (year ended March 31),	3,219
In 1897–1898 (year ended March 31),	4,668
In 1898–1899 (year ended March 31),	12,491
In 1899–1900 (year ended March 31),	31,997
In 1900–1901 (year ended March 31),	53,389
In 1901–1902 (year ended March 31),	40,211
In 1902–1903 (year ended March 31),	33,475
In 1903–1904 (year ended March 31),	41,133
During six months ended Sept. 30, 1904,	22,255
In 1904–1905 (year ended Sept. 30, 1905),	47,387
During fourteen months ended Nov. 30, 1906,	70,424
In 1906–1907 (year ended Nov. 30, 1907),	64,807
In 1907–1908 (year ended Nov. 30, 1908),	94,645
In 1908–1909 (year ended Nov. 30, 1909),	90,131
Total,	611,956

The serum was distributed to local boards of health, to hospitals, and to practitioners in 190 cities and towns, 60 of which used more than 100 bottles each. The following table shows the distribution: —

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1908, to Nov. 30, 1909.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Abington,	74	Boston — *Con.*	
Acton,	12	Training ship "Enterprise,"	25
Acushnet,	6	Braintree,	60
Adams,	134	Bridgewater,	12
Agawam,	30	Brockton,	412
Amesbury,	195	Brookfield,	6
Amherst,	13	Brookline,	499
Andover,	85	Buckland,	6
Arlington,	248	Cambridge,	1,112
Ashburnham,	54	Hospital for Contagious Diseases,	475
Athol,	42	Hospital,	99
Attleborough,	144	Canton,	6
Avon,	12	Massachusetts Hospital for Crippled and Deformed Children.	10
Ayer,	152	Chelsea,	349
Bedford,	8	Chester,	6
Belchertown,	18	Chicopee,	225
Belmont,	96	Clinton,	275
Massachusetts School for the Feeble-minded.	178	Cohasset,	48
Beverly,	120	Colrain,	6
Billerica,	25	Concord,	12
Blackstone,	129	Cummington,	6
Boston: —		Dalton,	12
Boston Floating Hospital,	23	Danvers,	359
Children's Hospital,	2,350	Dedham,	78
City Hospital,	31,984	Deerfield,	18
General supply,	9,327	Dennis,	12
Industrial School for Crippled children.	10	Douglas,	6
Infants' Hospital,	127	Duxbury,	12
Long Island Hospital,	10	East Bridgewater,	73
Massachusetts Charitable Eye and Ear Infirmary.	70	Easthampton,	49
Massachusetts General Hospital,	187	Easton,	54
Massachusetts Homœopathic Hospital.	2,629	Erving,	18
Massachusetts Infant Asylum,	99	Essex,	36
New England Hospital for Women and Children.	4	Everett,	331
Parental School,	6	Fall River,	900
St. Mary's Infant Asylum,	399	Falmouth,	6
State Hospital,	343	Fitchburg,	425

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1908, to Nov. 30, 1909 — Continued.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Foxborough,	80	Lynn,	2,000
Framingham,	96	Hospital for Contagious Diseases,	4,350
Franklin,	6	Malden,	925
Gardner,	119	Manchester,	49
Georgetown,	12	Mansfield,	132
Gloucester,	325	Marblehead,	72
Granby,	8	Children's Island Sanatorium,	45
Greenfield,	6	Marion,	6
Groveland,	6	Marlborough,	175
Hamilton,	6	Maynard,	12
Harvard,	6	Medfield,	48
Harwich,	21	Insane Asylum,	242
Hatfield,	12	Medford,	250
Haverhill,	1,725	Medway,	36
Hingham,	61	Melrose,	91
Holbrook,	18	Merrimac,	60
Holden,	12	Methuen,	85
Holliston,	4	Middleborough,	20
Holyoke,	850	Middleton,	30
Hopedale,	12	Milford,	111
Hopkinton,	36	Millbury,	48
Hubbardston,	4	Millis,	12
Hudson,	125	Milton,	36
Hull,	24	Monson,	24
Huntington,	84	Nantucket,	6
Hyde Park,	121	Natick,	62
Kingston,	42	Needham,	42
Lawrence,	2,275	New Ashford,	50
Leicester,	24	New Bedford,	775
Lenox,	30	Newbury,	6
Leominster,	350	Newburyport,	350
Lexington,	12	Newton,	287
Littleton,	6	Hospital,	1,290
Lowell,	1,125	North Adams,	72
Hospital,	24	North Andover,	95
Ludlow,	30	North Attleborough,	12

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1908, to Nov. 30, 1909 — Continued.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
North Brookfield,	12	Spencer,	18
Northampton,	125	Springfield,	1,425
Insane Hospital,	10	Sterling,	67
Northborough,	37	Stoneham,	202
Norton,	2	Stoughton,	70
Norwell,	6	Swampscott,	48
Norwood,	84	Taunton,	84
Oak Bluffs,	6	Tewksbury,	75
Orange,	12	State Hospital,	262
Palmer,	78	Topsfield,	39
Massachusetts Hospital for Epileptics.	6	Townsend,	87
Peabody,	208	Uxbridge,	30
Pembroke,	30	Wakefield,	100
Petersham,	12	Walpole,	18
Pittsfield,	300	Waltham,	387
Plymouth,	381	Hospital,	1,125
Provincetown,	46	Ware,	37
Quincy,	854	Warren,	36
Randolph,	55	Watertown,	43
Reading,	99	Wayland,	6
Revere,	200	Webster,	18
Rockland,	12	Wellesley,	123
Rockport,	24	West Boylston,	6
Salem,	584	West Brookfield,	24
Salisbury,	6	West Springfield,	37
Saugus,	43	Westborough,	12
Scituate,	12	Westfield,	30
Sharon,	6	Westford,	138
Shelburne,	36	Westminster,	8
Shirley,	103	Westport,	12
Industrial School for Boys,	47	Weymouth,	199
Shrewsbury,	12	Whitman,	36
Somerville,	2,350	Wilbraham,	12
Hospital for Contagious Diseases,	1,414	Williamsburg,	12
Southborough,	18	Williamstown,	36
Southbridge,	135	Wilmington,	80

Number of Bottles of Diphtheria Antitoxin distributed from Dec. 1, 1908, to Nov. 30, 1909 — Concluded.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Winchendon,	78	Worcester,	2,150
Winchester,	36	Hospital,	350
Winthrop,	48	Total,	90,131
Woburn,	178		

The total number of tubes of vaccine virus issued by the Board during the five years and two months ended Nov. 30, 1909, was as follows: —

	Tubes.
In 1904–1905 (year ended Sept. 30, 1905),	23,970
During fourteen months ended Nov. 30, 1906,	31,805
In 1906–1907 (year ended Nov. 30, 1907),	45,265
In 1907–1908 (year ended Nov. 30, 1908),	48,768
In 1908–1909 (year ended Nov. 30, 1909),	47,961
Total,	197,769

The vaccine virus was distributed as shown in the following table: —

Number of Tubes of Vaccine distributed from Dec. 1, 1908, to Nov. 30, 1909.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Abington,	82	Boston — *Con.*	
Amesbury,	286	Infants' Hospital,	277
Andover,	50	Massachusetts General Hospital,	184
Arlington,	300	Penal Institutions,	2,175
Ashby,	12	The Perkins Institute and Massachusetts School for the Blind.	25
Athol,	10	Braintree,	143
Attleborough,	209	Bridgewater,	45
Ayer,	98	Brockton,	35
Bedford,	25	Brookline,	554
Belmont: —		Cambridge,	1,587
Massachusetts School for the Feeble-minded.	90	Hospital,	15
McLean Hospital,	60	Canton,	18
Beverly,	80	Chelmsford,	73
Boston: —		Chelsea,	867
City Hospital,	1,275	Cheshire,	10
General supply,	11,767	Chicopee,	660

Number of Tubes of Vaccine distributed from Dec. 1, 1908, to Nov. 30, 1909 — Continued.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Clinton,	412	Mansfield,	57
Cohasset,	110	Marblehead,	160
Concord,	84	Marshfield,	63
State Reformatory,	800	Mattapoisett,	15
Cummington,	120	Medfield,	51
Danvers,	204	Medford,	96
Dedham,	448	Medway,	20
Duxbury,	52	Melrose,	183
East Bridgewater,	33	Merrimac,	25
Everett,	330	Methuen,	175
Fairhaven,	35	Middleton,	15
Fall River,	4,080	Milford,	90
Fitchburg,	700	Millbury,	155
Foxborough,	25	Milton,	30
Freetown,	5	Nantucket,	12
Gardner,	76	Needham,	98
Georgetown,	37	Newton,	614
Gloucester,	105	North Adams,	298
Groton,	28	North Andover,	37
Hamilton,	70	North Attleborough,	183
Haverhill,	10	Northfield,	10
Hingham,	120	Norwood,	200
Holbrook,	85	Orange,	25
Holden,	150	Oxford,	75
Holyoke,	1,000	Palmer,	90
Hudson,	13	Massachusetts Hospital for Epileptics.	150
Hull,	30	Pembroke,	10
Hyde Park,	239	Pittsfield,	93
Lawrence,	3,210	Plymouth,	189
Lee,	40	Princeton,	12
Leicester,	25	Provincetown,	12
Lexington,	112	Quincy,	710
Lincoln,	26	Randolph,	33
Littleton,	5	Revere,	436
Lynn,	1,040	Rockland,	109
Malden,	86	Russell,	50

Number of Tubes of Vaccine distributed from Dec. 1, 1908, to Nov. 30, 1909 — Concluded.

City or Town.	Number of Tubes.	City or Town.	Number of Tubes.
Salem,	109	West Newbury,	25
Sharon,	19	West Springfield,	15
Sherborn,	35	Westborough: —	
Somerville,	1,139	Insane Hospital,	125
Springfield,	1,325	Westfield,	200
Stoughton,	50	Westford,	141
Taunton,	885	Westminster,	60
Townsend,	45	Weymouth,	338
Wakefield,	311	Westport,	80
Walpole,	98	Whitman,	107
Waltham,	441	Williamstown,	15
Ware,	70	Wilmington,	45
Warren,	18	Winchester,	95
Watertown,	127	Woburn,	166
Wayland,	20	Worcester,	2,080
Wellesley,	149	Worthington,	80
Wenham,	10	Total,	47,961

REPORT

UPON THE

WORK OF THE BACTERIOLOGICAL LABORATORY

FOR THE

YEAR ENDED NOV. 30, 1909.

Report upon Diphtheria Cultures examined during the Year ended Nov. 30, 1909.

From Dec. 1, 1908, to Nov. 30, 1909, 4,123 cultures were received from 163 cities and towns in the State. Of these cultures, 2,232 were for the purpose of diagnosis and 1,891 were for release from quarantine.

The following table gives the number of cultures received from the different cities and towns and the results of the examinations: —

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Abington,	9	1	5	3
Adams,	21	4	11	6
Amesbury,	71	7	24	40
Andover,	7	1	6	–
Arlington,	65	6	15	44
Ashburnham,	19	3	5	11
Athol,	64	15	15	34
Attleborough,	53	13	21	19
Avon,	4	–	1	3
Ayer,	25	3	6	16
Barnstable,	1	–	1	–
Bedford,	6	2	4	–
Bellingham,	1	1	–	–
Belmont,	21	4	8	9
Beverly,	57	9	29	19
Billerica,	2	–	2	–
Blackstone,	3	2	1	–
Boston,	3	–	2	1
Braintree,	16	1	9	6
Brewster,	2	–	2	–
Bridgewater,	9	1	2	6
Brookfield,	3	1	1	1

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Buckland,	1	-	1	-
Cambridge,	1	-	1	-
Canton,	22	-	8	14
Carlisle,	1	-	-	1
Charlemont,	8	-	3	5
Chatham,	1	1	-	-
Chelsea,	149	13	43	93
Cheshire,	3	-	3	-
Chilmark,	1	-	1	-
Clinton,	2	1	1	-
Cohasset,	41	5	13	23
Concord,	24	2	8	14
Danvers,	23	5	12	6
Dartmouth,	2	-	2	-
Dedham,	47	5	23	19
Douglas,	1	-	1	-
Duxbury,	29	4	8	17
East Bridgewater,	5	1	2	2
Easton,	1	-	-	1
Edgartown,	2	1	1	-
Essex,	7	1	2	4
Everett,	155	25	66	64
Falmouth,	10	2	2	6
Foxborough,	26	-	25	1
Framingham,	26	9	11	6
Gardner,	216	20	46	150
Georgetown,	1	-	1	-
Gloucester,	2	-	2	-
Great Barrington,	4	-	3	1
Greenfield,	1	-	1	-
Groton,	4	-	3	1
Hamilton,	1	-	1	-
Hanover,	3	-	2	1
Harvard,	6	1	4	1
Hingham,	26	5	12	9
Holbrook,	11	-	11	-
Hopkinton,	2	1	1	-
Hudson,	29	4	12	13

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Hull,	4	1	3	-
Hyde Park,	53	7	19	27
Kingston,	20	5	5	10
Lawrence,	34	5	19	10
Lexington,	2	-	-	2
Lincoln,	5	-	5	-
Littleton,	6	-	4	2
Ludlow,	3	-	1	2
Lynnfield,	2	1	1	-
Malden,	345	37	109	199
Manchester,	9	3	4	2
Mansfield,	136	24	21	91
Marblehead,	45	3	25	17
Marion,	7	-	3	4
Marlborough,	95	17	48	30
Marshfield,	3	-	3	-
Maynard,	1	-	1	-
Medfield,	70	4	45	21
Medford,	158	31	86	41
Medway,	4	-	4	-
Melrose,	107	13	72	22
Merrimac,	22	4	-	18
Methuen,	14	1	8	5
Middleborough,	6	1	3	2
Middleton,	5	-	2	3
Millbury,	1	-	-	1
Millis,	15	2	8	5
Milton,	35	2	28	5
Natick,	18	1	14	3
Needham,	23	2	14	7
Newbury,	2	-	-	2
North Andover,	3	1	-	2
North Attleborough,	7	-	4	3
North Brookfield,	1	1	-	-
Northborough,	1	-	-	1
Northbridge,	1	-	-	1
Northfield,	2	-	2	-
Norwell,	10	2	-	8

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Norwood,	29	7	10	12
Oak Bluffs,	1	1	–	–
Orange,	3	1	1	1
Oxford,	2	1	1	–
Peabody,	36	5	13	18
Pembroke,	7	–	5	2
Pepperell,	3	–	–	3
Plymouth,	44	10	15	19
Provincetown,	8	4	1	3
Quincy,	76	15	43	18
Randolph,	12	4	6	2
Reading,	23	3	14	6
Revere,	94	4	58	32
Rockland,	1	–	1	–
Rockport,	31	4	11	16
Royalston,	3	–	–	3
Salem,	121	9	34	78
Sandwich,	10	2	1	7
Saugus,	52	4	32	16
Scituate,	16	3	4	9
Sharon,	7	1	3	3
Shelburne,	6	5	1	–
Shirley,	62	11	16	35
Somerville,	1	1	–	–
Southborough,	6	3	2	1
Southbridge,	58	8	13	37
Spencer,	21	–	1	20
Sterling,	15	1	5	9
Stoneham,	99	18	26	55
Stoughton,	48	12	23	13
Swampscott,	8	1	4	3
Taunton,	15	2	10	3
Templeton,	54	6	4	44
Tewksbury,	6	3	1	2
Topsfield,	24	5	4	15
Townsend,	27	2	20	5
Uxbridge,	4	2	1	1
Wakefield,	39	8	12	19

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.		Cultures examined for Release from Quarantine.
		Positive.	Negative.	
Walpole,	18	2	13	3
Wareham,	2	–	2	–
Warren,	18	1	10	7
Warwick,	1	–	–	1
Watertown,	52	5	20	27
Wayland,	5	1	4	–
Webster,	2	–	1	1
Wellesley,	13	2	3	8
West Boylston,	1	–	–	1
West Bridgewater,	2	–	2	–
West Brookfield,	14	2	5	7
Westborough,	15	2	6	7
Westfield,	10	3	6	1
Westford,	26	5	7	14
Westminster,	3	1	–	2
Weston,	1	–	1	–
Westport,	5	1	1	3
Weymouth,	41	7	29	5
Whitman,	12	3	5	4
Wilbraham,	1	–	1	–
Williamstown,	8	1	4	3
Wilmington,	18	3	10	5
Winchendon,	33	3	13	17
Winchester,	31	6	17	8
Winthrop,	30	1	16	13
Woburn,	50	13	12	25
Wrentham,	8	3	2	3
Totals,	4,123	579	1,653	1,891

REPORT UPON THE EXAMINATION OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

From Dec. 1, 1908, to Nov. 30, 1909, microscopical examination has been made of 2,013 lots of sputum and other material suspected of containing the bacilli of tuberculosis. This material has been received from 168 cities and towns in the State. The following table gives the places from which the material has been received and the results of the microscopical examination: —

City or Town.	Whole Number of Examinations.	Positive.	Negative.
Abington,	12	8	4
Adams,	25	11	14
Amesbury,	27	10	17
Andover,	5	1	4
Arlington,	18	2	16
Ashland,	12	–	12
Athol,	13	1	12
Attleborough,	31	9	22
Avon,	5	2	3
Barnstable,	9	2	7
Barre,	1	–	1
Bedford,	2	1	1
Bellingham,	1	–	1
Belmont,	2	1	1
Beverly,	20	7	13
Billerica,	1	–	1
Blackstone,	19	7	12
Boston,	13	3	10
Braintree,	11	2	9
Brewster,	1	1	–
Bridgewater,	6	3	3
Brockton,	2	2	–
Brookfield,	2	–	2
Cambridge,	10	–	10
Canton,	15	2	13
Chelsea,	36	9	27
Chicopee,	8	4	4
Clinton,	5	2	3
Colrain,	1	–	1
Concord,	28	2	26
Conway,	1	–	1
Cummington,	1	–	1
Danvers,	32	8	24
Dartmouth,	2	–	2
Dedham,	13	4	9
Dennis,	2	1	1
Dover,	1	1	–
Duxbury,	8	–	8

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
East Bridgewater,	7	1	6	Manchester,	6	1	5
Easton,	1	–	1	Mansfield,	24	9	15
Edgartown,	1	–	1	Marion,	5	3	2
Essex,	4	1	3	Marlborough,	24	5	19
Everett,	79	19	60	Marshfield,	3	3	–
Fall River,	13	6	7	Maynard,	6	2	4
Falmouth,	3	2	1	Medfield,	5	3	2
Foxborough,	15	3	12	Medford,	39	13	26
Framingham,	23	5	18	Melrose,	56	10	46
Gardner,	17	5	12	Mendon,	2	1	1
Gloucester,	8	2	6	Merrimac,	5	–	5
Great Barrington,	6	4	2	Methuen,	3	2	1
Groton,	1	–	1	Middleborough,	3	–	3
Hamilton,	4	–	4	Middleton,	4	2	2
Hanover,	7	2	5	Milford,	36	17	19
Hanson,	2	1	1	Milton,	11	1	10
Harwich,	2	1	1	Monterey,	1	–	1
Haverhill,	6	–	6	Natick,	22	5	17
Hingham,	19	4	15	Needham,	12	1	11
Holbrook,	5	2	3	New Bedford,	1	1	–
Holden,	2	1	1	New Marlborough,	1	–	1
Hopedale,	7	3	4	New Salem,	1	1	–
Hopkinton,	3	–	3	Newburyport,	1	–	1
Hudson,	4	1	3	Newton,	2	1	1
Hull,	2	–	2	North Adams,	7	3	4
Hyde Park,	28	11	17	North Andover,	2	–	2
Ipswich,	11	4	7	North Attleborough,	28	4	24
Lancaster,	1	–	1	Northfield,	1	1	–
Lawrence,	88	29	59	Norton,	5	1	4
Lee,	2	–	2	Norwell,	4	3	1
Lexington,	14	3	11	Norwood,	15	4	11
Littleton,	4	1	3	Oakham,	1	–	1
Ludlow,	1	1	–	Orange,	1	–	1
Lynn,	3	1	2	Peabody,	24	6	18
Lynnfield,	2	1	1	Pembroke,	2	–	2
Malden,	63	7	56	Pittsfield,	25	3	22

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Plymouth,	7	3	4	Wales,	1	–	1
Quincy,	82	25	57	Walpole,	6	3	3
Randolph,	13	3	10	Waltham,	1	–	1
Reading,	33	8	25	Ware,	7	1	6
Revere,	19	6	13	Wareham,	4	–	4
Rochester,	2	2	–	Warren,	11	2	9
Rockland,	19	3	16	Washington,	1	–	1
Rockport,	18	5	13	Watertown,	11	1	10
Salem,	140	58	82	Wayland,	3	1	2
Salisbury,	2	–	2	Wellesley,	13	3	10
Sandwich,	1	–	1	Wellfleet,	3	–	3
Saugus,	18	3	15	Wenham,	1	1	–
Scituate,	1	–	1	West Brookfield,	2	–	2
Shelburne,	3	1	2	Westborough,	1	–	1
Sherborn,	9	3	6	Westfield,	8	1	7
Shirley,	5	1	4	Westford,	2	–	2
Somerville,	2	–	2	Weston,	1	–	1
Southborough,	7	1	6	Westport,	7	2	5
Southbridge,	1	–	1	Weymouth,	26	5	21
Southwick,	1	–	1	Whitman,	20	3	17
Spencer,	5	2	3	Williamsburg,	7	5	2
Stoneham,	5	–	5	Williamstown,	12	4	8
Stoughton,	2	–	2	Wilmington,	14	2	12
Swansea,	1	–	1	Winchendon,	4	–	4
Taunton,	92	22	70	Winchester,	27	7	20
Templeton,	1	1	–	Winthrop,	11	1	10
Tewksbury,	1	–	1	Woburn,	37	7	30
Truro,	1	1	–	Wrentham,	2	–	2
Upton,	1	–	1	Totals,	2,013	536	1,477
Wakefield,	31	6	25				

TYPHOID FEVER.

Widal, Agglutinative or Serum Test.

During the year ended Nov. 30, 1909, the Widal test was carried out with 830 specimens of blood. Of these specimens, 54, or 6.5 per cent., gave a positive reaction. Specimens were sent in from 121 cities or towns. These facts are shown in detail in Table I. In a second table (Table II.) the specimens, positive and negative, are classified according to the day of the disease on which they were collected. A moderate number of second and third specimens from the same case were examined, so that the total number of tests made is somewhat over the number of cases of disease concerned. The methods used during the year were the same as those previously in use in the laboratory, and they have been amply described in the reports of the year 1900 and the years following.

Table I. — *Widal Test, Dec. 1, 1908, to Nov. 30, 1909, inclusive, classified according to the City or Town from which the Specimen was sent.*

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Abington,	5	–	5	Canton,	5	1	4
Acton,	2	–	2	Chelsea,	10	1	9
Amesbury,	2	–	2	Cheshire,	1	–	1
Andover,	2	–	2	Cohasset,	1	–	1
Arlington,	18	2	16	Concord,	5	–	5
Attleborough,	22	–	22	Danvers,	3	–	3
Avon,	1	–	1	Dartmouth,	1	–	1
Ayer,	1	–	1	Dedham,	7	1	6
Barnstable,	2	–	2	Dennis,	2	1	1
Belmont,	4	–	4	Duxbury,	4	1	3
Beverly,	9	1	8	Easthampton,	1	–	1
Blackstone,	2	–	2	Easton,	1	–	1
Boston,	2	–	2	Everett,	25	2	23
Braintree,	1	–	1	Falmouth,	3	–	3

TABLE I. — *Widal Test, etc.* — Continued.

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Foxborough,	1	–	1	Natick,	35	2	33
Franklin,	1	–	1	Needham,	15	2	13
Gardner,	6	–	6	Newburyport,	41	4	37
Gloucester,	6	1	5	Newton,	3	–	3
Groton,	1	–	1	North Adams,	6	–	6
Hadley,	1	–	1	North Attleborough,	5	–	5
Hamilton,	1	–	1	North Brookfield,	1	1	–
Hanover,	1	–	1	Northampton,	14	–	14
Hanson,	2	–	2	Northfield,	2	–	2
Harwich,	3	–	3	Norton,	1	–	1
Haverhill,	15	–	15	Norwood,	11	–	11
Hingham,	9	–	9	Oak Bluffs,	2	–	2
Holbrook,	4	–	4	Oakham,	1	–	1
Holden,	6	2	4	Orleans,	1	–	1
Hopedale,	2	–	2	Oxford,	5	–	5
Hopkinton,	2	–	2	Peabody,	1	–	1
Hull,	9	3	6	Pepperell,	3	–	3
Hyde Park,	22	2	20	Quincy,	13	–	13
Kingston,	3	–	3	Randolph,	3	1	2
Lancaster,	1	–	1	Reading,	8	–	8
Lawrence,	55	8	47	Revere,	12	–	12
Lunenburg,	1	1	–	Rockland,	7	1	6
Lynn,	69	–	69	Rockport,	5	–	5
Malden,	15	2	13	Rutland,	1	–	1
Marblehead,	1	–	1	Salem,	7	–	7
Marlborough,	11	–	11	Salisbury,	1	–	1
Maynard,	4	–	4	Saugus,	12	–	12
Medford,	25	–	25	Savoy,	1	–	1
Medway,	3	–	3	Scituate,	2	–	2
Melrose,	26	1	25	Sharon,	1	–	1
Middleborough,	2	1	1	Shirley,	2	–	2
Milford,	9	–	9	Shrewsbury,	1	–	1
Millis,	4	–	4	Somerville,	3	1	2
Milton,	3	–	3	Stoneham,	5	2	3
Nantucket,	2	–	2	Stoughton,	2	1	1

TABLE I. — *Widal Test, etc.* — Concluded.

City or Town.	Whole Number of Examinations.	Positive.	Negative.	City or Town.	Whole Number of Examinations.	Positive.	Negative.
Sutton,	2	–	2	Westport,	1	–	1
Swampscott,	5	–	5	Westwood,	1	–	1
Taunton,	18	3	15	Weymouth,	15	–	15
Upton,	1	–	1	Whitman,	5	–	5
Wakefield,	13	1	12	Williamsburg,	2	–	2
Walpole,	1	–	1	Williamstown,	2	–	2
Wareham,	1	–	1	Winchendon,	1	–	1
Watertown,	2	–	2	Winchester,	16	3	13
Wayland,	2	–	2	Winthrop,	7	–	7
Westfield,	8	–	8	Woburn,	13	1	12
Westford,	4	–	4	Worcester,	4	–	4
Weston,	5	–	5	Totals,	830	54	776

TABLE II.—*Widal Test, according to Stage of Disease, Dec. 1, 1908, to Nov. 30, 1909, inclusive.*

Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.		Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.	
	Positive.	Negative.		Positive.	Negative.
1,	–	1	16,	2	11
2,	–	9	17,	1	9
3,	–	14	18,	2	10
4,	3	45	19,	–	6
5,	4	30	20,	–	6
6,	1	36	21,	–	16
7,	3	78	22,	1	7
8,	4	48	23,	–	7
9,	3	27	24,	–	7
10,	4	49	25,	1	3
11,	3	38	26,	–	3
12,	–	23	27,	–	3
13,	–	17	28,	–	9
14,	6	50	29,	–	3
15,	2	20	30,	–	5

TABLE II. — *Widal Test, etc.* — Concluded.

Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.		Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.	
	Positive.	Negative.		Positive.	Negative.
31,	–	5	43,	–	1
32,	–	2	44,	–	1
34,	–	2	45,	–	2
35,	–	3	48,	–	1
36,	–	1	49,	–	2
37,	–	1	60,	–	1
38,	–	1	79,	1	–
39,	–	3	91,	–	1
41,	–	1	Not stated,	13	156
42,	–	2	Totals,	54	776

MALARIA.

From Dec. 1, 1908, to Nov. 30, 1909, 38 blood specimens were received, to be examined for the presence or absence of the malaria parasite. Of these, 5 were positive and 38 were negative. The percentage of positive cases was 11.6 per cent.

The following table shows the city or town from which the specimens, positive and negative, were derived: —

City or Town.	Number of Cases.	Positive.	Negative.
Attleborough,	1	–	1
Belmont,	1	–	1
Dedham,	2	1	1
Duxbury,	1	–	1
Hingham,	1	–	1
Hopkinton,	2	1	1
Hull,	5	1	4
Hyde Park,	2	1	1
Lynn,	1	–	1
Melrose,	7	–	7
Natick,	10	–	10
Norwood,	4	1	3
Rockport,	1	–	1
Salem,	1	–	1
Saugus,	1	–	1
Winchester,	2	–	2
Winthrop,	1	–	1
Totals,	43	5	38

Report upon Investigations

of

Local Outbreaks of Infective Diseases.

Report upon Investigations of Local Outbreaks of Infective Diseases.

Following are accounts of local outbreaks of disease investigated by agents of the Board: —

THE OCCURRENCE OF INFANTILE PARALYSIS IN MASSACHUSETTS IN 1909.[1]

The medical profession of to-day is confronted with the task of constructing a new literature on the subject of infantile paralysis. What was written five years ago is to-day largely out of date, and the standard text-books cannot naturally present the latest point of view so rapid has been the recent progress of our knowledge in regard to this disease. The chief contributors to this rapid advance have been, first and foremost, Flexner and Lewis in demonstrating the etiology, Wickman, of Sweden, in giving us a new symptomatology and defining types not before recognized, and Harbitz and Scheele, of Norway, in formulating the pathology.

The present paper will consist, first, of a condensed report of the recent progress of our knowledge with regard to the disease, and, secondly, of the data obtained with regard to the disease in this State in 1909 by the State Board of Health.

I. REPORT OF PROGRESS.

The most important step in our knowledge of the disease consists in the establishment during the past year of its infectious character by several observers. With the ability to produce the disease in monkeys by inoculation, there has been given the opportunity to study its etiology, symptoms and pathology, which opportunity did not exist before.

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[1] Portions of this report were read in abstract before a joint session of the American Orthopedic and Pediatric Societies in Washington on May 4, 1910, and before the Massachusetts Medical Society in Boston, June 8, 1910. Reprinted from the "Boston Medical and Surgical Journal," July 14, 1910. Reported for the Massachusetts State Board of Health by Robert W. Lovett, M.D., Boston.

Experimental Production.

Infantile paralysis has been recently shown to be an infectious disease, caused by a living organism so small that it can pass through the finest bacterial filter. It is invisible to the microscope and the ultramicroscope.[17] This places the disease in a class with those caused by a filterable virus, similar diseases of this class being yellow fever, foot and mouth disease, pleuro-pneumonia of cattle, etc. It can be caused in monkeys by inoculation with an emulsion of certain tissues from a human being dying of the disease, and from affected monkeys.[41, 17, 10, 30, 50]

The virus is contained in the brain and spinal cord, the mucous membrane of the nasopharynx, infected lymphatic glands, in the salivary glands,[10] and, in the acute stage, in the blood and cerebro-spinal fluid.[17]

The disease may be caused by inoculation by the following routes: intracerebral, subdural, intraneural and perineural, intraperitoneal, subcutaneous, by the circulation, and by implantation in the anterior chamber of the eye.[10, 17, 41]

By the digestive route it has been caused by introducing an emulsion into the stomach by means of a catheter and by introduction of the virus into intestines paralyzed by opium.[41]

By the respiratory route the disease has been caused by rubbing the nasal mucous membrane after scarification[17] with a virulent suspension, by the same procedure without scarification, by inhalation of a virulent emulsion, and by implantation of infected tissue in the trachea.[41]

The fact that the disease may be caused by virus entering both respiratory and digestive tracts must be remembered when we come to inquire how the virus enters the human body.

Inoculations into horses, calves, goats, pigs, sheep, rats, cats, mice,[30] rabbits,[39] chickens,[42] guinea pigs[30] and dogs have proved negative except for the results of Krause and Meinicke,[24] who caused paralysis in rabbits by inoculation with virulent material, but their results are not generally accepted by other observers as they are in contradiction to practically all other experimental work and not sufficiently supported by pathological evidence.

The virulence of an emulsion is not impaired by drying for seven days, by freezing nor by suspension in glycerine,[10, 17, 30] but is injured by a temperature of 45° to 50° C.[17] The virus is not always affected by dilution, a solution of one to a thousand working as quickly and effectually as the full strength.[41]

The stage of incubation in monkeys is from six to upwards of thirty days, and the long incubation period in monkeys suggests the possibility that in the human being some of the late fall and early winter

cases may have acquired their infection when the disease was prevalent in August and September. The ordinary incubation period in human beings is not known. It is generally stated as from one to fourteen days.

Immunity.

One attack of the disease apparently confers immunity to future attacks.[17, 10, 31, 41] This is the accepted clinical history in human beings, and has been found to be the case in monkeys inoculated experimentally.

Active immunization in monkeys has been secured by the repeated injection of small doses of virus, after which a full dose has had no effect.[17]

Passive serum protection has been obtained by mixing with an active dose of the virus an equal amount of the blood serum of a recovered monkey, which neutralizes the effect of the virus, and in the same way the blood serum of children who have recovered, when mixed with the virus in proper proportions, neutralizes its effect.[17] Attempts to secure a neutralizing serum from horses who have received repeated injections of virus have not been successful. Even if we had at hand a therapeutic serum for this disease, it must be evident that such a serum to be of use must be used early in the disease, and at present our diagnostic knowledge is not sufficient to enable us to use it before the destruction occurs in the cord. The diagnosis is now rarely made before the paralysis occurs, and a better knowledge of the early symptoms and diagnostic signs of the disease is one of our most urgent needs, and indicates the line in which our investigation for the present year should progress.

Diagnosis.

In the matter of clinical diagnosis, the last year has added a little to our knowledge, chiefly in the way of a better knowledge of early symptoms. The eight types of the disease as described by Wickman are not, however, sufficiently known in the English language, and a translation of his book would be of great value (Wickman: Beiträge zur Kenntniss der Heine Medinschen Krankheit, Berlin, 1907), although a short abstract has been made of it.[18]

Müller,[33] investigating, at the request of the authorities, an epidemic in Westphalia in 1909, considered three symptoms of great importance in the early stages. These were (1) tendency to profuse sweating, (2) hyperesthesia and sensitiveness to movements, and (3) leucopenia. Respiratory and digestive symptoms were common in the earlier stages, and the incubation period was at least five days.

Krause[23] was commissioned by the government, in 1909, to investigate an epidemic, consisting of 436 cases, occurring in Germany in the

neighborhood of Hagen. He found digestive symptoms present in 90 per cent. of all cases at the onset, and occasionally respiratory symptoms. He calls especial attention to the importance of sweating and tenderness as early symptoms.

The later laboratory findings suggest that certain characteristics of the blood and cerebro-spinal fluid in the stage preceding paralysis may enable us to make an earlier and surer diagnosis, but these findings have not yet appeared in print.

Increasing Frequency of Occurrence.

It is generally believed that infantile paralysis is becoming more common and more widespread of late years, but one must bear in mind that there is a possibility that this is because the disease is better known and more frequently recognized. As this is a matter of importance, it seems proper to examine the evidence on this point.

The recognition of outbreaks of infantile paralysis is of comparatively recent date. Bergenholz, a Swede, writing in 1881, is generally credited with having been the first to recognize and describe such an outbreak with sufficient accuracy to make it acceptable. Since that time outbreaks have been reported with increasing frequency. From the time of the first generally accepted outbreak until the close of 1909 is, roughly, thirty years. If this interval be subdivided into periods of five years, beginning with 1880–84 inclusive and ending with 1905–09 inclusive, and if we set down in each period the number of outbreaks reported, we have the following table: —

Period.	Cases.	Outbreaks.	Average Number of Cases.
1880–84,	23	2	11.5
1885–89,	93	7	13.0
1890–94,	151	4	38.0
1895–99,	345	23	15.0
1900–04,	349	9	39.0
1905–09,	8,054	25	322.0

Distribution of Outbreaks.

The recent outbreaks have been widely distributed. From Norway and Sweden have been reported large and carefully studied epidemics, especially in the last ten years. Zappert,[46] in 1908 and 1909, collected 266 cases in Vienna and lower Austria, and Ghon noted many cases in upper Austria (Styria and Carinthia). In Germany, in 1909, the disease was very prevalent. The Westphalia epidemic of 436 cases[23] has been spoken of above. In Rhenish Prussia there were said to have been about 100 cases, and around Marburg about 50. There were cases

in the province of Hanover and about 50 cases in Silesia. Numerous small epidemics were reported. It is estimated that there must have been over 1,000 cases in Germany in 1909.[47] In Holland, 24 cases were reported from Leyden, and others between August and October in other parts of the country.[47]

England seems to have been comparatively immune, and only a small epidemic of 8 cases was reported from Spain. Although no large epidemic occurred in France, there was a consensus of opinion among the medical men quoted by Netter that an unusually large number of cases of infantile paralysis had been seen in 1909.[47, 49]

The United States suffered severely. Minnesota[48] had several hundred cases; Nebraska,[36] 619; Kansas, about 80; and Massachusetts, nearly 1,000.

The report[51] of the New York epidemic of 1907 has just become available for study. The fact that this epidemic of 2,500 cases was the largest ever reported, the painstaking character of the work done and the scientific standing of the committee in charge of the investigation make the report of the greatest importance and value. It is impossible in this place to abstract so condensed and exhaustive a work.

A most interesting and important epidemic of 140 cases has been reported as occurring in 1909 in the Province of Santa Clara, in Cuba.[53] Previous epidemics have been reported from the temperate zones of the north and south hemispheres, chiefly in the northern parts of the former. The Cuban epidemic, as the first reported from the tropics, possesses peculiar interest as to season, distribution, etc. Apparently the disease did not exist in Cuba prior to 1907. In 1907 and 1908 one or two suspicious or authenticated cases appeared in the neighborhood of Havana, the disease becoming epidemic in the Province of Santa Clara in 1909. A survey of the field makes it seem very probable that the disease was imported from New York as a result of the 1907 epidemic there, and that certain unknown determining conditions made the Province of Santa Clara susceptible to a severe outbreak. As in the temperate zones, the disease occurred during the summer, reaching its maximum in July and August. The chief incidence was between the ages of one and three; males were predominantly affected; and the black race was evidently much less affected than the white, in 72 cases the proportion being: whites, 60; mixed race, 4; negroes, 8. The mortality rate was 7.89 per cent.

The time has gone by when the routine reports of epidemics is of any especial value, nor is the exact tabulation of numbers of epidemics of any particular use except as throwing light on the general distribution of the disease, and possibly in this way defining some of its characteristics.

The disease is manifestly prevalent, and it is widespread and increasing. Useful work in the future will consist in the exact and careful house-to-house study of epidemics, both large and small.

Of the 8,054 cases reported in the last five years (number, of course, only approximately correct), the United States contributed 5,514 cases, or about five-sevenths of the total number of cases. The bulk of these cases has, moreover, been reported from the northern States, the outbreaks in the southern States being insignificant. In the same way in Europe, Norway and Sweden contributed about 1,500 cases and Germany practically the rest, except for an outbreak in Australia, which occurred in March, which is their early fall.

As the literature has been very carefully gone over, and as, in the present state of interest in the subject, it seems fair to assume that large outbreaks in any civilized country have been reported, it would seem that the following conclusions were justified: —

1. That outbreaks of infantile paralysis have very greatly increased in several parts of the world in the last five years in a measure not to be explained in any way by the increased interest in the disease.

2. That it is more prevalent in cold than in warm countries.

3. That from the northern part of the United States have been reported more cases than from any part of the world.

The study of these 70 outbreaks, reaching over a period of thirty years, has led, of course, to the knowledge of certain facts with regard to the disease, but they have not given us the essential facts as to how the disease enters the body nor how to prevent or check its spread.

Relation to Influenza.

A recent book [52] deals with the theory that the disease is merely a form of influenza, a contention already discussed prior to 1905 and antagonized by Wickman. The book in question deals with a study of 303 cases occurring in Sweden, each case being considered by itself. The point of view of the author is shown in the following quotation: "I must, therefore, regard this (the intermittent type of influenza) as a very certain proof for my view, acquired on other grounds, that acute infantile paralysis is a nervous form of influenza." Recent progress in the epidemiology of infantile paralysis makes this view seem improbable.

Transmissibility.

In the writings of the last year there is no dissent from the opinion that the disease is communicable. Direct transmission is apparently frequent, transmission by means of a healthy carrier is more than prob-

able, and infection occasionally appears to remain in a house where the disease had previously occurred.

On the other hand, the disease is evidently not very "contagious" in the ordinary acceptance of the term. In the epidemic in the Deerfield valley, in Massachusetts, in 1908, so carefully studied by Emerson,[2] there were 67 cases. There were 166 other children in the families of those affected, and 86 other children known to be in intimate contact with the 67. Of the 252, 4 later developed the disease.

Hill,[48] of the State Board of Health of Minnesota, has contributed a careful study of the transmissibility of the disease, written in a spirit of scientific skepticism. Of 161 cases reported as anterior poliomyelitis, he accepted only 85 as surely valid, and analyzed 81 of these, occurring in 69 families. Sixty-nine of these cases were primary and 12 occurred secondarily in the same families. The secondary cases thus were 17 per cent. of the primary. Contrasting this with the records of other infectious diseases in the same State, the percentage of secondary cases to primary was as follows: —

	Per Cent.
Scarlet fever,	40
Typhoid fever, about	30
Diphtheria,	29
Anterior poliomyelitis,	17

Of persons known to have been exposed to diphtheria, scarlet fever and anterior poliomyelitis, the percentage contracting the disease was as follows: —

	Per Cent.
Scarlet fever,	22
Diphtheria,	17
Anterior poliomyelitis,	6

The disease is thus apparently less readily transmissible than the diseases mentioned in persons exposed, but such figures cannot be considered representative until the abortive cases are included.

The study of the epidemiology of a disease falls into two parts, — the study in the laboratory and the study in the field. The most notable contribution as yet to our knowledge of this disease is from the laboratory, where Flexner and Lewis have established its infectious nature. This fact has narrowed the field of our inquiry and enables us to pursue a more definite and promising scheme, but one should remember that work in the field, comparatively fruitless as it has so far been, holds its place. We knew for many years the organism of malaria and the pathological changes occurring in the disease, but we could not control malaria

until we found that it entered the body through the agency of the mosquito. So it is quite possible to us to know much of the bacteriology and pathology of a disease from the laboratory without being able to control or suppress it, and such knowledge must be supplemented by field work; that is, a study of external conditions to round out our investigation and to make it as effective as we should wish.

II. INFANTILE PARALYSIS IN MASSACHUSETTS IN 1909.

In the year 1909, Massachusetts suffered as much from the disease as any country in Europe; as many cases were reported here as in the two other most severely affected States in the Union — Nebraska and Minnesota — taken together.

In Massachusetts, in 1907, we had begun the investigation of the disease by sending out inquiry blanks to be filled in by the general practitioner. That resulted in a loose collection of 234 cases, the results of which were published.[1] In 1908, half of our 136 cases occurring in the State were located in Franklin County, and these 67 cases were thoroughly studied by Emerson, who lived in the district a month for the purpose. These studies were published.[2]

In 1909 it was decided to take up the matter more seriously. A special agent, Mr. Sheppard, a fourth-year student at the Harvard Medical School, was detailed as a special investigator, and in February, 1910, another special investigator was added to the staff in the person of Dr. Hennelly, a recent graduate of the Harvard Medical School and of the Boston City Hospital. It was thought desirable to have expert advice in conducting the inquiry, and three gentlemen were requested to act as an advisory committee to the Board. These were Dr. Theobald Smith, professor of comparative pathology; Dr. M. J. Rosenau, professor of preventive medicine and hygiene, and Dr. J. H. Wright, pathologist to the Massachusetts General Hospital and assistant professor of pathology, all of the Harvard Medical School. The secretary of the Board, Dr. Mark W. Richardson, has given freely of his time and effort in conducting the details of the inquiry. This advisory committee has met the members of the Board who are concerned in the inquiry at frequent conferences, studied the reports submitted and advised as to the most promising lines of investigation.

The two investigators have conducted a house-to-house investigation and have filled out their own blanks; they have been instructed to work in all cases through the family physician; they have obtained from the family a careful history of the attack and they have examined the affected children. It has not been possible under these conditions to make rapid progress, and at this time only 150 cases have been thus carefully studied.

It seemed to us better to confine the investigation to certain localities, making it exhaustive in certain affected districts in the neighborhood of Boston, rather than to take up a scattered investigation throughout the State. Up to this time the expense of the inquiry had been borne by the Board out of its regular appropriation, but in January, 1910, the Board asked the Legislature for a special appropriation of $5,000 to enable the Board to make a proper and adequate inquiry into this disease as it occurred in the State in 1910. This sum of money was voted without question or opposition. It is our purpose to have on hand a sufficient number of investigators during the coming summer to be able to look into the surroundings of every case within forty-eight hours of the time when the case is reported.

In presenting for the Board some of the results obtained in 1909, it is only proper to say that in the present state of our knowledge no one can say which data are relevant and important and which are not. It is possible that certain facts which now seem of no importance may be of assistance to some future investigator. So far as practicable, our data are presented in graphic form. There are three classes of cases dealt with in this report: (*a*) the total number reported (923); (*b*) the number in which blanks were filled out (628); (*c*) the number thoroughly studied (150). All three classes are utilized in different tables, some being available for one purpose and some for another.

Distribution in the State.

A consideration of the distribution of the disease in the State of Massachusetts for the past three years shows that in all three years the disease occurred in scattered foci in all parts of the State, but was more frequent in the river valleys than away from rivers; that a case rarely occurred in a town without one or more cases in contiguous towns, and that localities severely affected one year were lightly affected the next; *e.g.*, the outbreak in the upper Connecticut valley in 1908 was followed by very few cases in 1909 in that region. In the next year but one, however, localities markedly affected may again show many cases; *e.g.*, in 1907 the extreme western end of the State showed many cases, in 1908 almost none, and in 1909 again many cases. The metropolitan district shows, of course, a large number of cases, and it will be noted that in general there were more cases of the disease in the towns north of Boston than in towns south of it.

Distribution by cities and towns of the 923 cases reported in 1909 follows: —

Distribution by Cities and Towns.

City or Town.	Number of Cases.	City or Town.	Number of Cases.
Adams,	16	Manchester,	1
Amesbury,	2	Mansfield,	3
Andover,	1	Marblehead,	1
Arlington,	3	Marshfield,	2
Ashland,	1	Maynard,	1
Athol,	12	Medfield,	1
Avon,	1	Medford,	13
Ayer,	6	Medway,	2
Barre,	1	Melrose,	10
Belmont,	5	Merrimac,	3
Beverly,	1	Methuen,	1
Blackstone,	1	Milford,	1
Boston,	299	Millis,	4
Braintree,	1	Milton,	4
Brockton,	7	Monson,	1
Brookline,	6	Montague,	1
Buckland,	1	Natick,	18
Cambridge,	49	Nantucket,	2
Canton,	2	Needham,	1
Chelmsford,	2	New Bedford,	13
Chelsea,	4	Newburyport,	5
Clarksburg,	1	Newton,	14
Clinton,	3	North Adams,	11
Concord,	1	North Brookfield,	2
Cummington,	1	Northampton,	1
Danvers,	6	Norton,	1
Dartmouth,	1	Norwood,	2
Dedham,	6	Orange,	2
Deerfield,	1	Palmer,	2
Easton,	2	Pembroke,	1
Egremont,	1	Pittsfield,	17
Everett,	11	Plainfield,	2
Fairhaven,	3	Quincy,	12
Fall River,	10	Reading,	4
Fitchburg,	2	Revere,	9
Foxborough,	4	Richmond,	1
Framingham,	1	Rockland,	2
Franklin,	3	Salem,	2
Gardner,	2	Salisbury,	2
Gloucester,	9	Saugus,	1
Great Barrington,	18	Savoy,	1
Groveland,	3	Scituate,	4
Hanover,	2	Sharon,	3
Hardwick,	1	Sheffield,	1
Haverhill,	16	Shelburne,	1
Holbrook,	1	Somerville,	18
Holliston,	1	South Hadley Falls,	1
Hudson,	2	Southbridge,	4
Hull,	4	Spencer,	1
Hyde Park,	3	Springfield,	1
Ipswich,	3	Sterling,	1
Lancaster,	1	Stockbridge,	1
Lawrence,	8	Stoneham,	4
Lee,	2	Stoughton,	1
Lenox,	8	Stow,	1
Leominster,	7	Swampscott,	1
Leverett,	2	Taunton,	2
Littleton,	1	Topsfield,	1
Lowell,	5	Uxbridge,	2
Lunenburg,	1	Wakefield,	3
Lynn,	11	Walpole,	8
Malden,	30	Waltham,	9

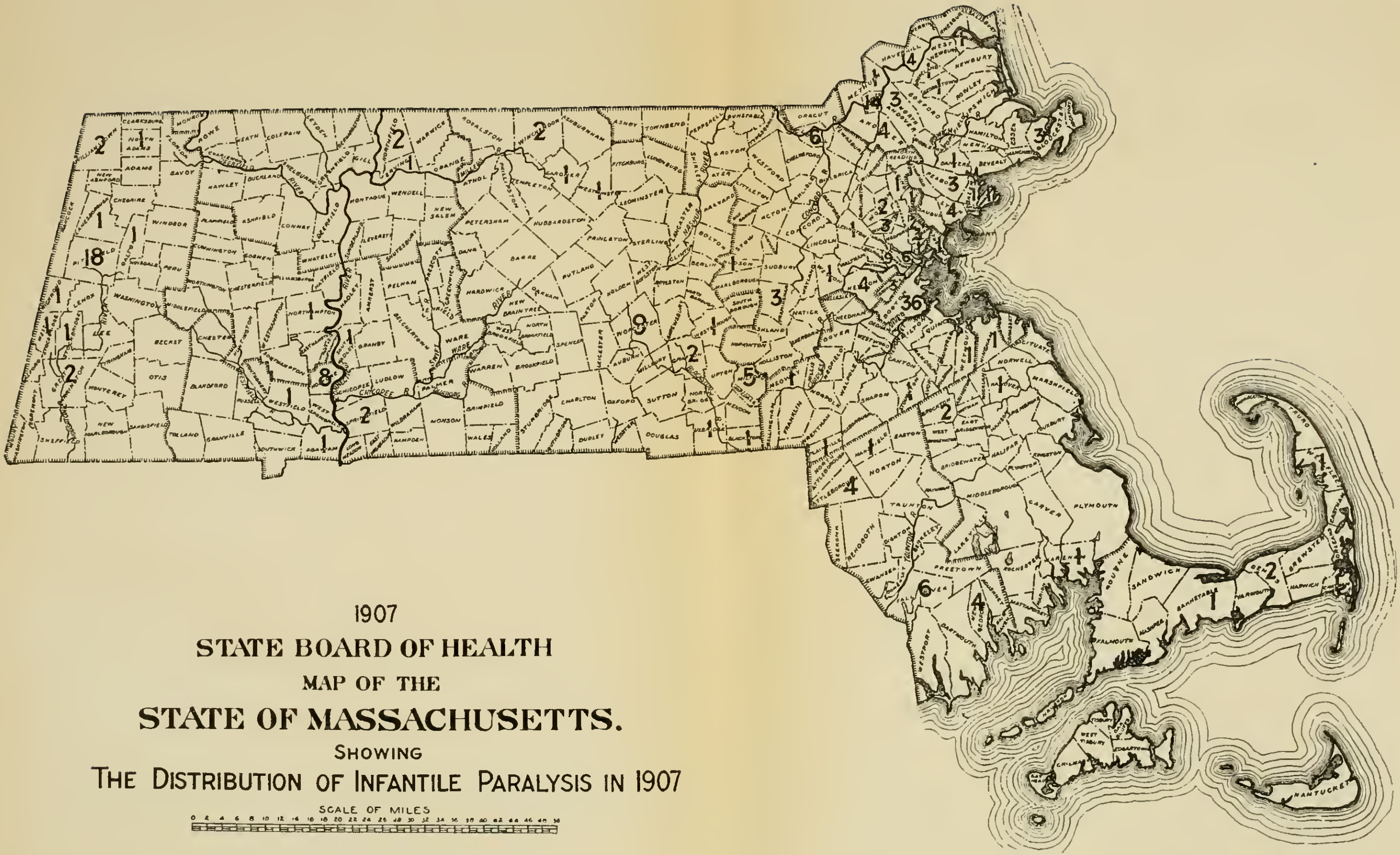

1907
STATE BOARD OF HEALTH
MAP OF THE
STATE OF MASSACHUSETTS.
SHOWING
THE DISTRIBUTION OF INFANTILE PARALYSIS IN 1907
SCALE OF MILES

FIG. 1.

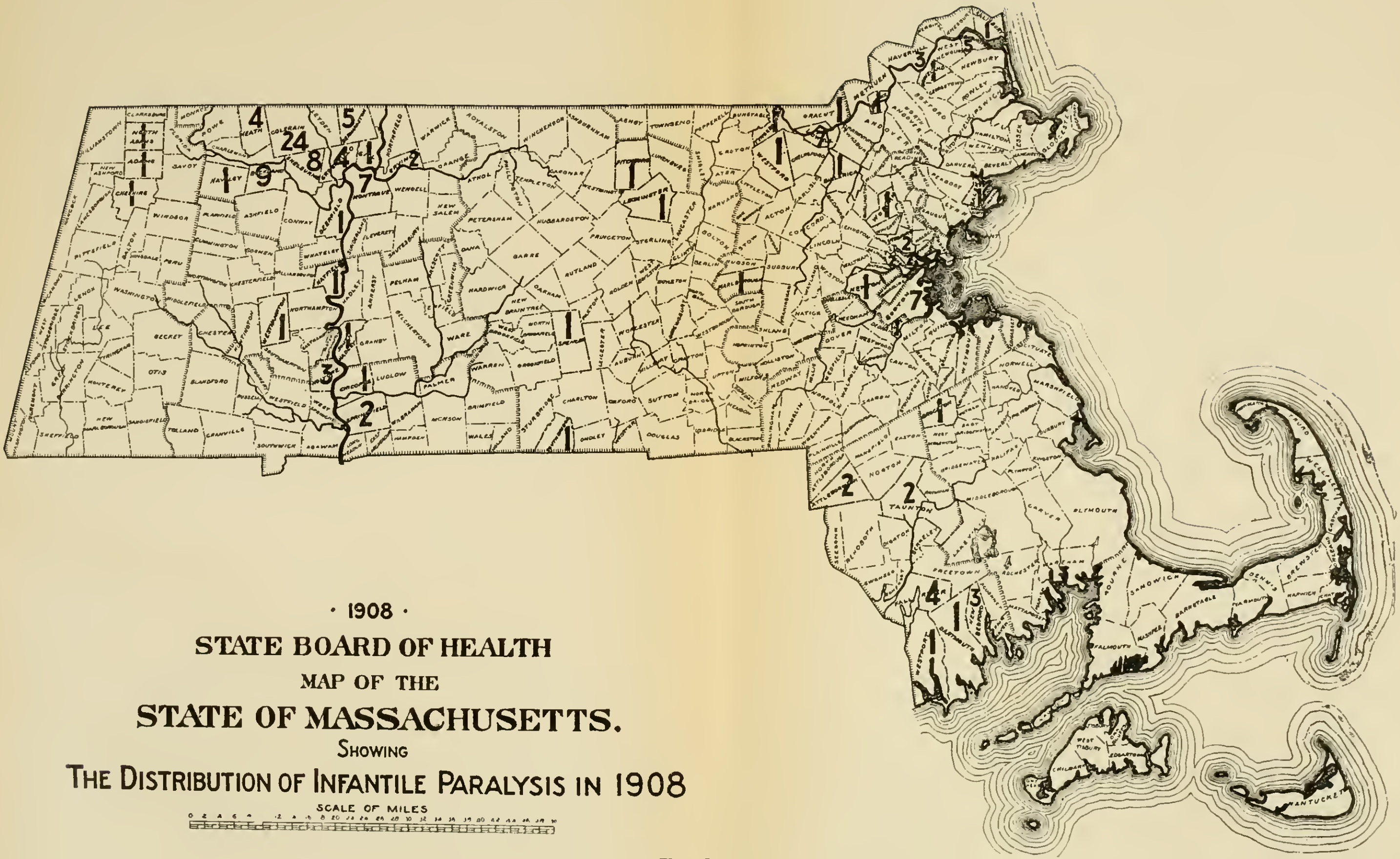

· 1908 ·
STATE BOARD OF HEALTH
MAP OF THE
STATE OF MASSACHUSETTS.
SHOWING
THE DISTRIBUTION OF INFANTILE PARALYSIS IN 1908
SCALE OF MILES

FIG. 2.

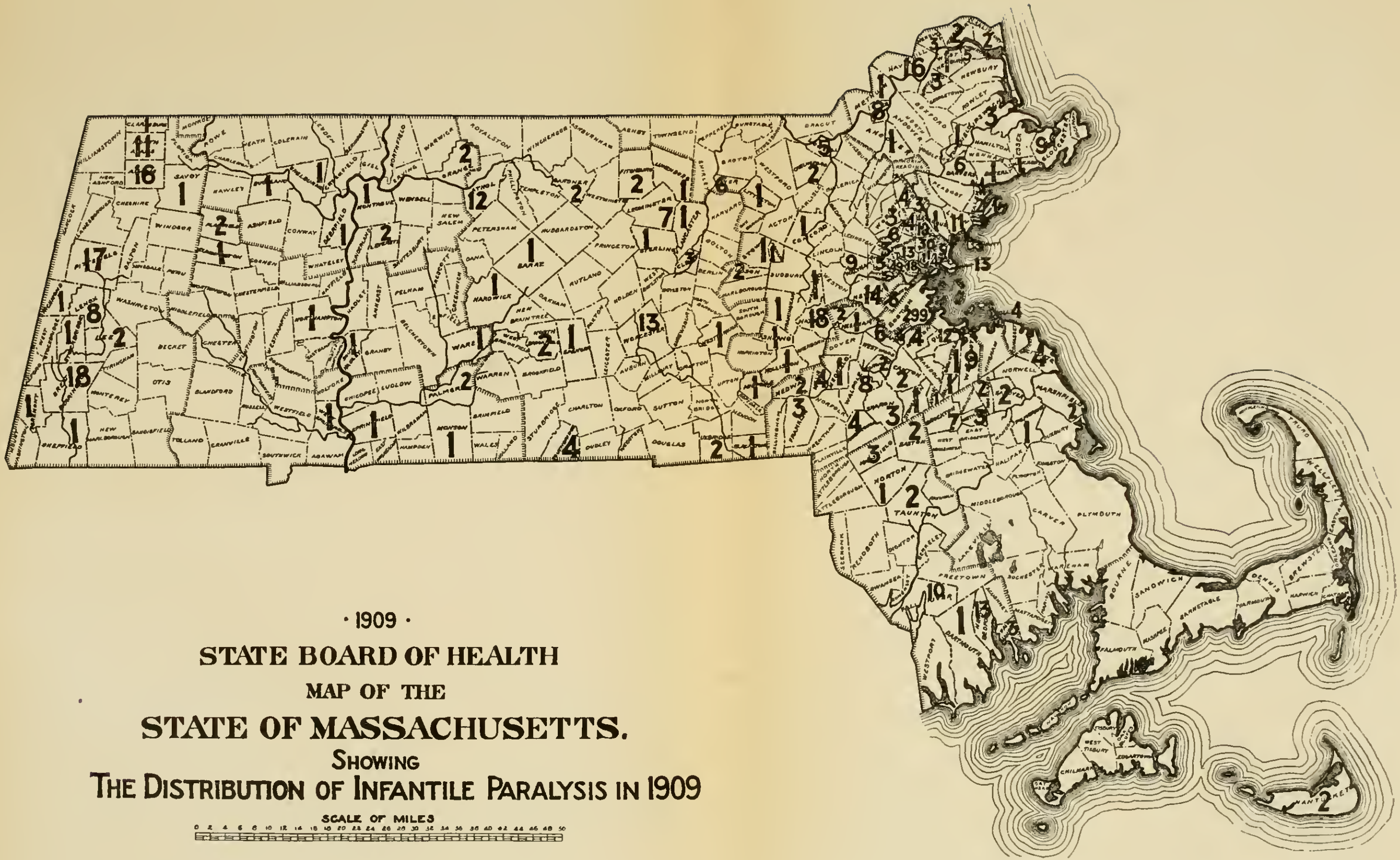

· 1909 ·
STATE BOARD OF HEALTH
MAP OF THE
STATE OF MASSACHUSETTS.
SHOWING
THE DISTRIBUTION OF INFANTILE PARALYSIS IN 1909
SCALE OF MILES

FIG. 3.

Distribution by Cities and Towns — Concluded.

City or Town.	Number of Cases.	City or Town.	Number of Cases.
Ware,	1	Whitman,	3
Watertown,	5	Winchester,	6
Wayland,	1	Winthrop,	13
Wellesley,	2	Woburn,	3
West Newbury,	1	Worcester,	13
West Springfield,	1		
Westborough,	1	Total,	923
Weymouth,	9		

Distribution in Boston.

Analyzing the relative prevalence of the disease in the different parts of Boston, the distribution of the cases shows nothing. The incidence was greatest in Dorchester, which is on the shore and not altogether thickly settled; next, in Charlestown, on the shore and densely populated; next, in the city proper, densely settled; and so on, districts on the shore and inland alternating, and density of population having apparently no influence.

	Population, 1905.	Number of Cases.	Incidence per Thousand.
Dorchester,	93,771	76	.81
Charlestown,	39,983	24	.60
Boston, city proper,	159,512	86	.54
Roxbury, West Roxbury and Jamaica Plain,	161,097	67	.42
Brighton,	21,806	9	.41
East Boston,	51,334	20	.39
South Boston,	67,877	17	.25
	595,380	299	.50

Relative Distribution in Cities and Towns.

There are 354 cities and towns in Massachusetts, in 136 of which there occurred cases of infantile paralysis in 1909. These 136 cities and towns were listed according to the prevalence of the disease in each per 1,000 of the inhabitants. The incidence ran from 526 per 100,000 inhabitants to 15 in 100,000. Taking the first 25, where the incidence per 1,000 was highest, the average population was 3,295, and only 4 towns were over 7,000. Taking the last 25 on the list, where the incidence per 1,000 was least, the average population was 34,860, and no city or town was under 7,000 in population. Therefore, in 1909 the disease was relatively much more prevalent in small towns than in the cities and larger towns.

List of 25 Cities and Towns where the Disease was most prevalent.

Town.	Population.	Cases.	Incidence per Thousand.
Plainfield,	382	2	5.26
Millis,	1,089	4	3.66
Leverett,	703	2	2.83
Great Barrington,	6,388	18	2.81
Lenox,	3,058	8	2.61
Ayer,	2,386	6	2.51
Walpole,	4,000	8	2.00
Hull,	2,060	4	1.94
Natick.	9,705	18	1.85
Easton,	1,089	2	1.83
Savoy,	549	1	1 81
Winthrop,	7,814	13	1.70
Richmond,	601	1	1.66
Athol,	7,305	12	1.64
Merrimac,	1,884	3	1.59
Scituate,	2,597	4	1.54
Sharon,	2,085	3	1.44
Egremont,	721	1	1.38
Cummington,	740	1	1.35
Groveland,	2,401	3	1.25
Salisbury,	1,622	2	1.23
Foxborough,	3,364	4	1.18
Adams,	13,685	16	1.17
Belmont,	4,360	5	1.15
Marshfield,	1,763	2	1.12

List of 25 Cities and Towns where the Disease was least prevalent.

Town.	Population.	Cases.	Incidence per Thousand.
Gardner,	13,066	2	.15
New Bedford,	85,516	13	.15
Maynard,	7,147	1	.14
Spencer,	7,121	1	.14
Lynn,	84,623	11	.13
Marblehead,	7,209	1	.13
Saugus,	7,189	1	.13
Montague,	7,707	1	.13
Braintree,	7,595	1	.13
Brockton,	55,039	7	.12
Lawrence,	7,050	8	.11
Ware,	8,858	1	.11
West Springfield,	8,897	1	.11
Methuen,	9,608	1	.10
Fall River,	106,486	10	.09
Chelsea,	40,080	4	.09
Framingham,	11,749	1	.08
Milford,	12,722	1	.08
Taunton,	30,967	2	.064
Beverly,	13,386	1	.061
Fitchburg,	34,263	2	.058
Salem,	39,019	2	.051
Lowell,	94,889	5	.05
Northampton,	21,075	1	.04
Springfield,	84,237	1	.012

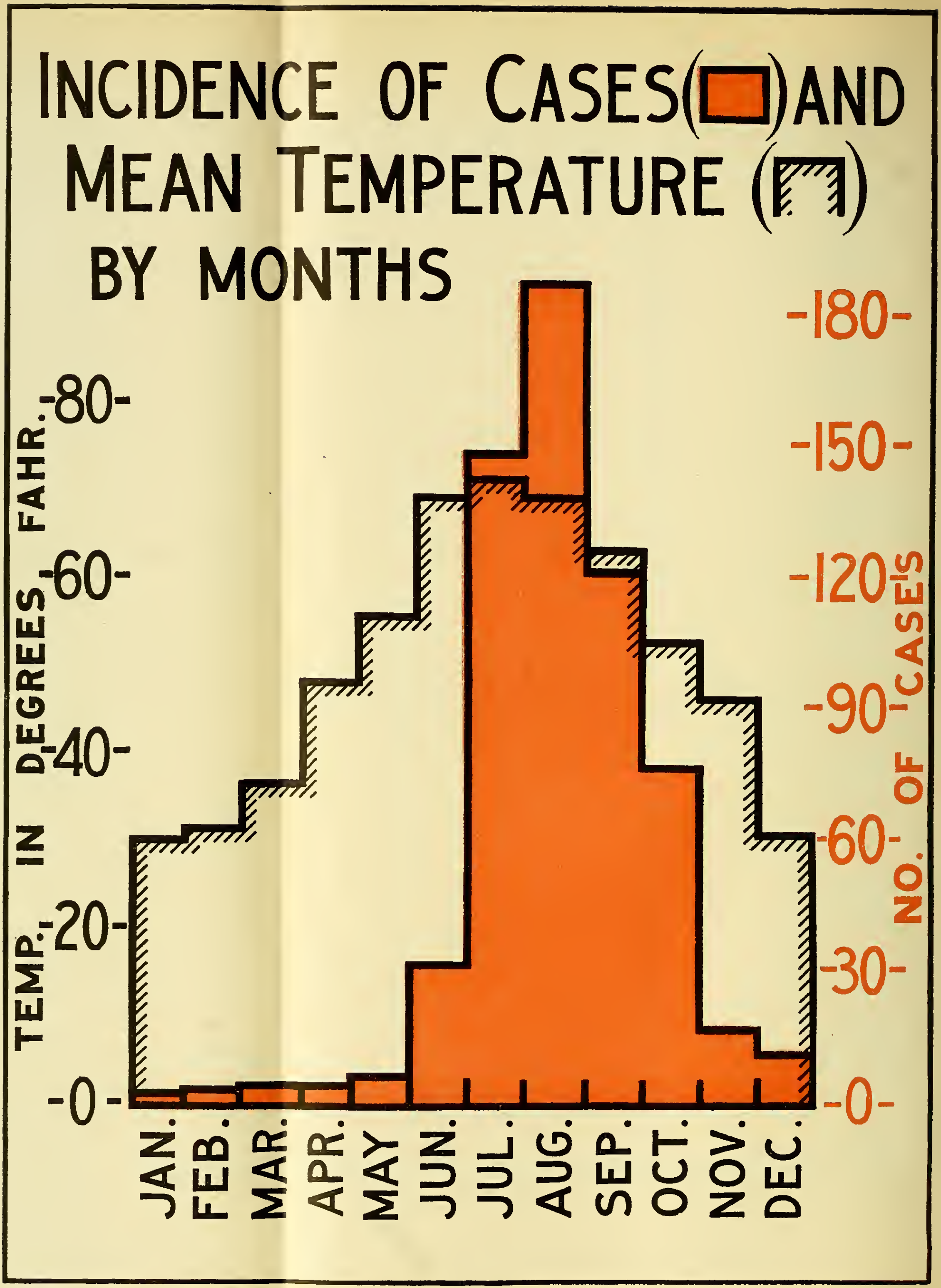
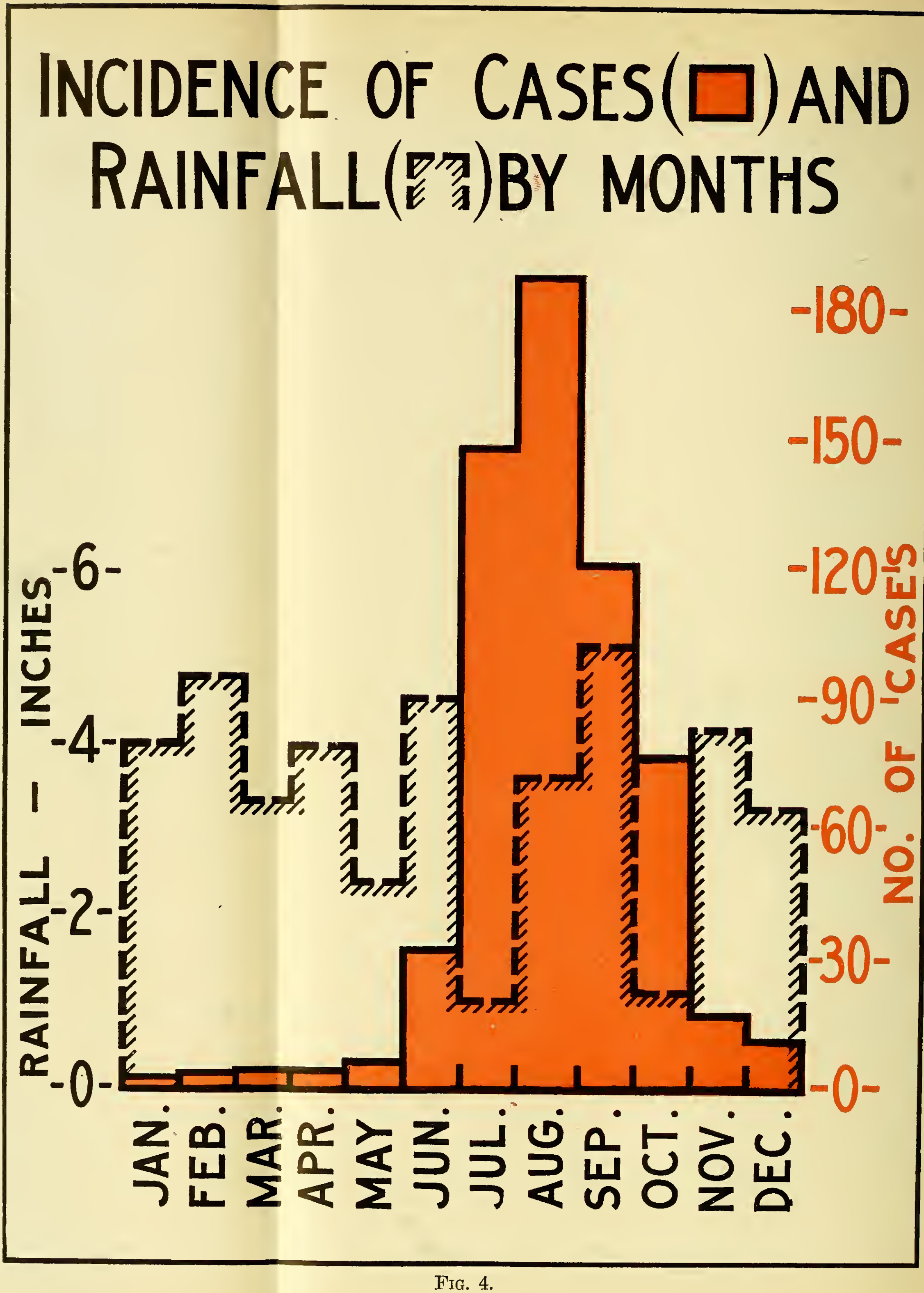

INCIDENCE OF CASES ( ) AND
MEAN TEMPERATURE ( )
BY MONTHS
TEMP. IN DEGREES FAHR.
-80-
-60-
-40-
-20-
-0-
-180-
-150-
-120-
-90-
-60-
-30-
-0-
NO. OF CASES
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.

Fig. 5.



INCIDENCE OF CASES ( ) AND
RAINFALL ( ) BY MONTHS
RAINFALL - INCHES
-6-
-4-
-2-
-0-
NO. OF CASES
-180-
-150-
-120-
-90-
-60-
-30-
-0-
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.

FIG. 4.

General Conditions.

Aside from the immediate environment of the patients, there are certain general considerations of possible interest.

Rainfall by Years.

The last six years have been very dry. In 1907 there was practically a normal rainfall, and 234 cases in the State. In 1908, a very dry year with 7 inches deficiency of rainfall, there were few cases — 136. In 1909, with more rain (3 inches deficiency), there were 923 cases. In Massachusetts the prevalence of the disease by the year has not, therefore, been coincident with deficiency of rainfall.

Deficiency Rainfall, 1904–1909, inclusive.

Year.	Cases in State.	Actual.	Normal.	Deficiency.
1904, ...	–	43.81	45.16	—1.35
1905, ...	–	37.60	–	—7.56
1906, ...	–	43.21	–	—1.95
1907, ...	234	44 49	–	—0.67
1908, ...	136	37.61	–	—7.55
1909, ...	923	42.10	–	—3.06
				—22.14

Rainfall by Months in 1909.

The chart of the rainfall in 1909 in the State, arranged by months, does not correspond with the prevalence of the disease in the State, arranged also by months, the driest month preceding the month of greatest frequency of the disease in the same way that the driest year preceded the year when the disease was most prevalent.

Temperature by Months in 1909.

The curve of the average monthly temperature in Massachusetts in 1909 does not correspond with the curve of the frequency of the disease, the highest average temperature falling away before the highest incidence of the disease occurs.

Number of Families affected and Possible Abortive Cases.

To make the following analyses clearer, the following table is important as showing that the 150 cases carefully studied occurred in 142 families, and also showing the probable existence of a fairly large number of abortive cases associated with them.

The 150 cases of paralysis carefully studied occurred in 142 families. The total number of children under fifteen in these 142 families was 479. The total number of children sick from any cause in these families contemporaneously with the occurrence of paralysis was 187, and 12 adults. Of the 187 sick children, 149 were paralyzed; of the 12 adults, 1 was paralyzed. This leaves 49 cases of contemporaneous illness, not followed by paralysis, which are to be reckoned as possible abortive cases of the disease.

Analysis of Cases thoroughly studied.

[150 cases of paralysis in 142 families.]

Total number of children,		479
Number of children sick,	187	
Number of adults sick,	12	
		199
Number of children paralyzed,	149	
Number of adults paralyzed,	1	
		150
Possible abortive cases,		49

Surroundings of Patients.

The following tables relate to the environment of the patients in the 150 cases carefully studied, and are largely self-explanatory.

The nearness of the house to the railroad was investigated on account of the data of certain Swedish observers, showing its frequency in these localities. Even in a district where railroads were frequent, the bulk of the cases were well removed from the tracks.

Nearness of House to Railroad.

	Cases.
On,	7
Within 20 yards,	4
Within 40 yards,	4
Within 100 yards,	17
Within 200 yards,	22
Within 300 yards,	13
Within 500 yards,	37
Over 500 yards,	46
	150

Nearness to Water (Stream, Pond or Beach).

	Houses.
Within 50 yards,	6
Within 100 yards,	27
Within 200 yards,	21
Within 300 yards,	8
Within 400 yards,	10
Within 500 yards,	7
Within 600 yards,	5
Within 700 yards,	1
Within 800 yards,	9
Over 800 yards,	56
Cases,	150

Analyzing the age of infected houses, it is evident from the following table that most of the 150 cases occurred in old houses. Yet the majority of houses in a city are old. But in Dorchester, where many cases were investigated, building is active and many of the houses are new. It seemed as if the average age of infected houses was probably higher than that of the houses of those districts taken as a whole.

Age of House.

	Houses.
1 year old,	2
1½ years old,	1
3 years old,	5
4 years old,	3
5 years old,	4
10 years old,	28
15 years old,	24
20 years old,	17
30 years old,	22
30+ years old,	44
	150

Sanitary Conditions.

	Cases.
Excellent,	36
Good,	50
Fair,	37
Bad,	19
Not stated,	8
	150

Location of House.

	Cases.
High,	43
Medium,	65
Low,	42
	150

	Cases.
Dry,	105
Damp,	45
	150

Character of House.

	Cases.
Detached house,	64
Tenement house,	86
	150

Floor of House inhabited by Family.

	Cases.
The whole house,	55
The first floor (3 of which also occupied basement),	43
The second floor,	36
The third floor,	20

Character of Sewage Disposal.

	Cases.
Sewer, metropolitan,	109
Sewer, city,	19
Cesspool,	13
Vault,	8
Privy,	1
	150

Character of Water Supply.

	Cases.
Metropolitan,	109
Town,	17
City,	22
Well,	2
	150

The amount of dust as described by the families may be taken at its face value, the majority of cases reporting from a moderate amount upward.

Relation to Dust.

	Cases.
No dust,	–
Very little dust,	29
Moderate amount of dust,	83
Much dust,	37
Excessive amount of dust,	1
	150

Prevalence of Vermin, Insects and Rodents.

Inasmuch as the disease in many respects suggests that it is insect-borne, the following table was compiled from the account of the family aided by the observation of the investigators. It may be added that the investigators were fully aware of the importance of obtaining accurate answers to this question.

Among 142 families, 134 had vermin, etc., as follows: —

	Houses.
Flies were present in	113
Mosquitoes were present in	75
Mice (house) were present in	63
Rats were present in	54
Ants, red and black, were present in	35
Roaches were present in	35
Bedbugs were present in	31
Spiders were present in	28
Mice (field) were present in	20
Squirrels were present in	6
Biting flies were present in	3
Grubs and caterpillars were present in	3
Fleas were present in	2
Brown-tail moths were present in	1
Moles were present in	1

Paralysis in Domestic Animals.

The occurrence of paralysis among domestic animals and fowls has been found to coincide with outbreaks of the disease in the human beings in some instances reported. Inquiries were, therefore, addressed to every veterinary surgeon and every animal inspector in Massachusetts as to the occurrence of such paralysis in animals in 1909. The reported cases were then carefully laid off on a map of the State and the relative distribution of the animal cases compared with that of the human cases. No correspondence was found to exist, so that, so far as these data can be depended on, no obvious connection on the whole existed between the two classes of cases in Massachusetts in 1909.

The health of the domestic animals in the 142 families is shown in the table. In 34 out of 87 families having domestic animals, sickness, paralysis or death occurred in these animals about the time of the paralysis in human beings.

The relation of this disease to paralysis in domestic animals is, however, a matter requiring much more extensive investigation and is at present wholly unknown.

Data as to Domestic Animals.

	Families.
No animal of any kind in	55
Animals in	87
	142

(*a*) 22 homes had 28 dogs without sickness.
53 homes had 73 cats without sickness.
11 homes had 760 hens without sickness.
9 homes had 17 birds without sickness.
7 homes had 11 horses without sickness.
1 home had 20 cows without sickness.
1 home had 3 pigs without sickness.
1 home had 1 lamb without sickness.

(*b*) 3 homes had 3 dogs with sickness.
10 homes had 10 cats with sickness.
4 homes had 6 hens with sickness.
1 home had 1 bird with sickness.

(*c*) 2 homes had 2 cats with paralysis.
3 homes had 4 hens with paralysis.
1 home had 1 dog with paralysis.

(*d*) 4 homes had deaths in 5 cats.
4 homes had deaths in 4 hens.
1 home had deaths in 2 rats.
1 home had death in 1 dog.

18 homes had illness in 20 animals.
6 homes had paralysis in 7 animals.
10 homes had deaths in 12 animals.

Total, 34 homes had illness, paralysis or deaths in 39 animals.[1]

[1] The following letter, which reached the Board through the State Board of Health of Minnesota, is of possible interest in this connection: —

"In my veterinary practice during the past five or six years I have found a disease appearing among one and two year old colts that shows a line of symptoms corresponding very closely to anterior poliomyelitis of children. I have had from 5 to 10 cases a year during this time, the cases always occurring during the summer months, and the majority of them during the month of August. The affected colts are usually found in the pasture, unable to stand. The owner sometimes will notice an unsteady gait for twenty-four hours before entire loss of motion occurs. At first these colts have a rise of temperature ranging from 103° to 104° F.; pulse and respiration accel-

Relation to Rabies.

The relation of the disease to rabies was investigated, and in 3 of the towns carefully studied epidemics had occurred in the past, but no outbreak of rabies in 1909 had any relation to these 150 cases of paralysis, and no one of the 150 paralyzed children had in the past received the Pasteur treatment.

Communicability.

With regard to evidences of communicability in our series of cases, it seems proper that in so important a matter our conclusions should only be presented after a very careful study of all the facts.

We have had instances of direct contagion from child to child, with an incubation period of one to fourteen days. We have had a number of instances of what appeared to be indirect contagion by a healthy carrier, and finally we have had 11 instances in the 150 cases where the disease followed intimate contact with persons with old infantile paralysis, often of many years' standing. The latter cases seemed to be unworthy of mention in a serious report, but after consultation with our advisory board it seemed worth while to allude to the matter for what it is worth; *e.g.*, a child of two and one-half was not, so far as known, in direct or indirect contact with any acute case, but was, previous to his attack, daily fondled and cared for by a girl of fourteen, paralyzed twelve years previously. On Aug. 14, 1909, he developed the disease. The Board would not wish to be understood as advocating the view that chronic cases were sources of infection, but the frequency of such histories makes it proper to mention the matter as one worthy of following up, although the general history of other diseases caused by a filterable virus would make it seem unlikely.

Instances of what would appear to have been contagion occurred in 35 out of 150 cases. They may be analyzed as follows: —

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erated; animal sweats profusely; appetite remains fairly good, but there is some trouble noticed in swallowing, especially water; slight derangement of the bowels, tending toward constipation; more or less tympanitis present; retention of urine, — for a few hours at least; head drawn back so the end of the nose tends to assume a position somewhat on a line with the neck. The death loss is less than 10 per cent., but in those that do recover the market value is depreciated to a very great extent because of the faulty gait the animal assumes after an attack of this disease, due to atrophy and contraction of certain muscles, or certain groups of muscles. It seems that the flexor muscles of the limbs especially are more often affected than the extensor, and in almost all the cases some of these deformities are likely to remain permanent. The flexors of the limbs are liable to contract and cause volar flexion of the fetlock. The elevators of the head are also likely to become affected, so as to cause the head to have a poky appearance; that is, it is carried out from the body.

"After one of these attacks the colt will remain down from one to three weeks, and will then continue to improve for a period of one year, but seldom, if ever, makes a complete recovery.

Dr. C. S. Shore.

Lake City, Minnesota."

Instances of Contagiousness.

	Cases.
Certain direct contact with acute case,	14
Certain direct contact with abortive case,	1
Certain direct contact with chronic case,	14
Certain direct contact with both acute and chronic cases,	2
Certain indirect contact with acute case by third person,	4
	35

The contact was so intimate between the cases, and so constant, that there is no certain means of determining the day of the illness on which the sick child gave the disease to the other, or, in other words, the period of incubation in the recipient.

Families with more than One Case.

	Cases.
134 families with	1
7 families with	2
1 family with	3
142	

Cases among the Acquaintances of Patient.

(*a*) In 22 instances there occurred 1 other acute case, either shortly before or after.

(*b*) In 2 instances there were 2 acute cases each among acquaintances.

(*c*) In 2 instances, 4 acute cases each.

(*d*) And in 1 instance there were 6 acute cases.

(*e*) In 13 instances there was 1 chronic case each among the acquaintances of patient.

It is not demonstrated that contact necessarily took place between these individuals.

As bearing on the question of contagion, the places to which visits were made within a month before the attack was investigated.

Places visited by Patient before Attack.

(*a*) No history of visits known, 42; (*b*) Revere Beach, 38; (*c*) City Point, 18; (*d*) Savin Hill Beach (Dorchester), 15; (*e*) Boston, 12; (*f*) Nantasket, 11; (*g*) Winthrop Beach, 8; (*h*) Dorchester Beach, 6; (*i*) Gloucester, 5; (*j*) Dewey Beach (Charlestown), 5; (all these places were known to be infected areas); (*k*) 3 other towns were visited by 4 cases each; of these 3 towns, 2 were known to be infected areas; (*l*) 8

other towns were visited by 3 cases each; of these 8 towns, 7 were known to be infected areas; (*m*) 10 other towns were visited by 2 cases each; of these 10 towns, 7 were known to be infected areas; (*n*) 40 other towns were visited by 1 case each; of these 40 towns, 25 were known to be infected areas.

Institutions for Children.

It was suggested by the advisory committee that it might be worth while to look into the prevalence of the disease in asylums, etc., where healthy children lived and were removed from the ordinary conditions of street life, many of which institutions were in the midst of infected districts. Forty-five such institutions were investigated, where 3,600 young children lived. Only 1 child of the 3,600 developed the disease, and this was under such remarkable conditions that the case may be mentioned.

E. R. (age two years and four months) entered the St. Mary's Infant Asylum in Dorchester on Aug. 28, 1908. In February, 1909, the child had measles and was taken to the South Department of the Boston City Hospital. No other sickness since becoming an inmate of the asylum.

On Sept. 30, 1909, the child had a typical attack of infantile paralysis; the diagnosis was made by the attending physician and confirmed at the Children's Hospital. Partial paralysis of one leg still persists.

This child is one of a class of walking children in the institution, numbering in all 40. At the time of his illness, 2 or possibly 3 other children suffered from slight vomiting and diarrhœa. Nothing else remarkable.

This child lived as regular institution children do, playing with his 40 companions on one floor and one porch.

The child never left the institution after he entered save to go to the City Hospital at the time of the attack of measles, several months before. No one had visited the child or sent food, toys, etc., for several months before onset.

During the month of September only 6 new children were admitted to that part of the asylum. None of these had illness of any sort.

The child, at the time of onset, showed no marks or bites or wounds. His diet was that usually given in an asylum for children, viz., mashed potatoes, meat juices, soups, bread and milk, oatmeal, and, very rarely, fruit. The children sleep 16 in a room, and all eat in the same dining hall.

The child was not isolated during his illness and no other cases occurred.

Conditions, General and Special, preceding the Attack.

The general and individual conditions preceding the attack are shown in certain matters in the following tables: —

Swimming or Wading.

The frequency with which swimming or wading was mentioned as an antecedent in previous years attracted our attention and was embodied in a question on our blank. Nearly half of the cases had been swimming or wading in water contaminated by sewage shortly before the onset of the disease.

Out of 150 cases, 62 were swimming or wading just before onset.

Water was contaminated by sewage in	54 instances.
Water was contaminated more or less in	8 instances.
	62
No history of swimming or wading in	88 instances.
	150

Exposure to Heat, Cold or Dampness preceding the Attack.

	Cases.
To heat, ...	39
To cold, ...	25
To dampness, ...	36
Not exposed, ...	50
	150

Accident, Fall or Overexertion preceding Attack.

107 cases had no such history.
34 cases had history of fall.
9 cases had history of overexertion.

150

Diseases prevalent in Town at Time of Occurrence of Infantile Paralysis.

	Families.
Not known,	103
La grippe,	5
Measles,	7
Whooping cough,	4
Digestive troubles,	8
Rheumatism,	3
Mumps,	2
Scarlet fever,	2
Malaria,	2
Tonsilitis,	2
Coryza,	1
Chickenpox,	1
Typhoid,	1
Diphtheria,	1
	142

Diet.

General (45 had limited or modified diets),	105
(*a*) Raw cow's milk,	120
(*b*) Condensed milk,	14
(*c*) Breast milk and other food,	14
(*d*) Breast milk alone,	–
Fish,	80
Fruit,	100
Berries,	89
Meat,	90
Canned goods: (*a*) fruits; (*b*) vegetables; (*c*) or fish,	82
Cereals,	15
Bread and butter,	23
Vegetables,	90
Stews and soups,	11
Eggs,	14
Tea, 2; cocoa, 3; coffee, 1,	6
Malted milk,	2
Ice cream,	3
Predigested and beef juices,	4
Candy,	2
Bananas,	6

Articles of diet are said to have been taken by the affected children, as shown in the accompanying table. As many of the cases partook

of several kinds of food, the total is much in excess of the total number of cases.

It is important to note that no child living on breast milk alone in the 150 cases carefully studied was affected by the disease.

Data as to School Attendance.

	Cases.
School was not attended by	115
School was attended by	35[1]
	150

Of the 35 cases attending school: —

	Cases.
Edward Everett, Dorchester, was attended by	3
Winthrop Primary (including center) was attended by	4
Concord Street, Boston, was attended by	2
Savin Hill School was attended by	2
Each at a different school,	22
School unknown,	2
	35

Possibly favoring Conditions preceding or attending Infection.

Insect bites or stings, 35; wounds, 13; sore throat, 42; diarrhœa, 35; otitis media, 2; coryza, 4; measles, 1; pin worm, 1; bronchitis, 1.

Ninety-three had one or more of the above possible sources of infection; 57 had no such history. Total, 150 cases.

Incidence of the Disease.

Sex. — Three hundred and sixty-three males and 263 females were affected.

Age. — By the figures it is seen that the incidence is greatest between the ages of two and three. After ten years of age the chart deals only with ten-year periods and the average number of cases per year only is represented.

In the chart of age periods it is shown that only 7 per cent. of the cases occur in the first year of life, but 71 per cent. of cases occur in the first five years and 87 per cent. of cases in the first ten years.

[1] School attendance, was not, however, necessarily continuous up to the time of the attack.

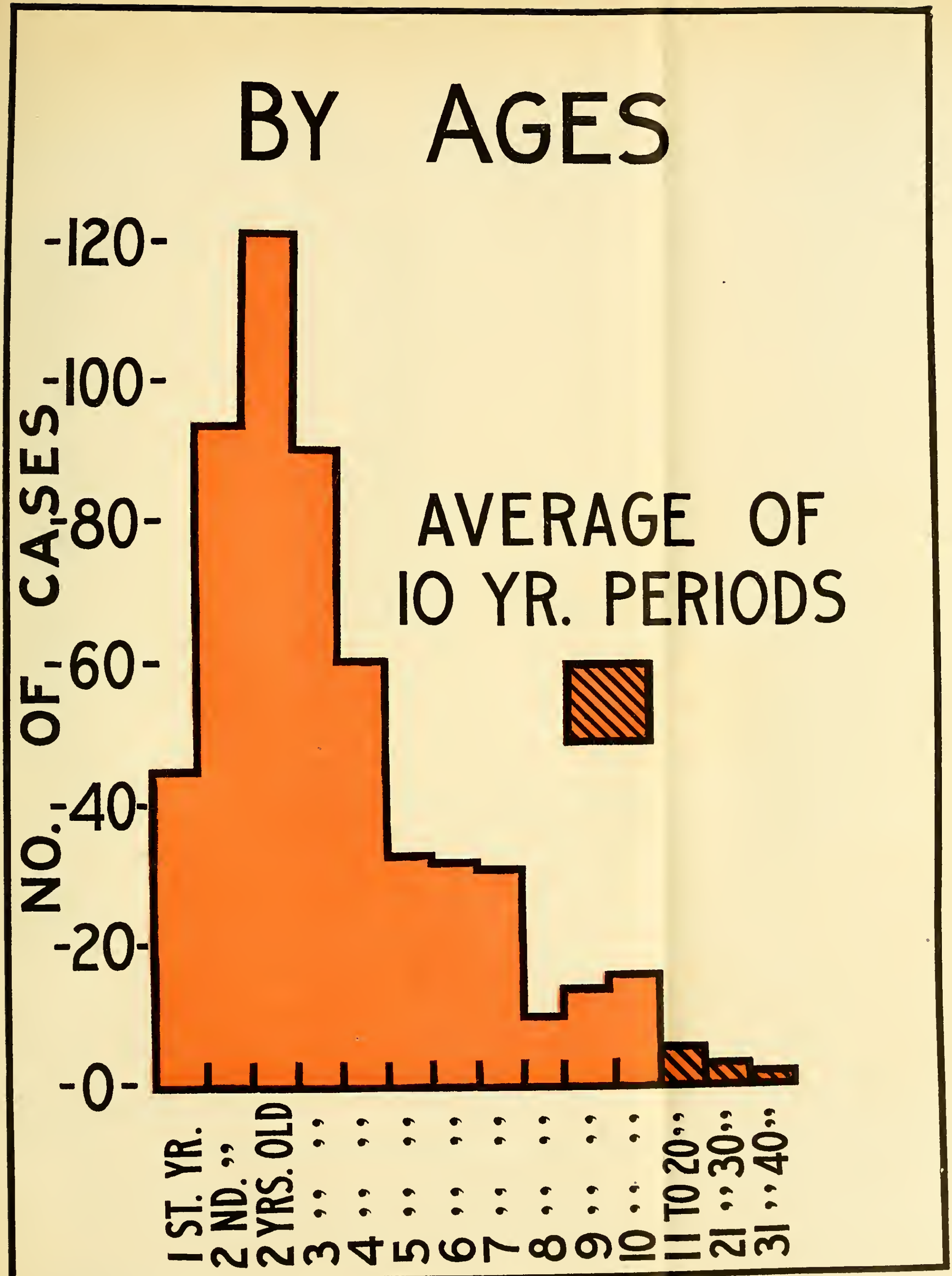
BY AGES
NO. OF CASES
-120-
-100-
-80-
-60-
-40-
-20-
-0-
AVERAGE OF
10 YR. PERIODS
1 ST. YR.
2 ND. ,,
2 YRS. OLD
3 ,, ,,
4 ,, ,,
5 ,, ,,
6 ,, ,,
7 ,, ,,
8 ,, ,,
9 ,, ,,
10 ,, ,,
11 TO 20 ,,
21 ,, 30 ,,
31 ,, 40 ,,

Fig. 6.

By Ages.

Age.	Cases.	Age.	Cases.
3 weeks,	1	10 years,	15
2 months,	2	11 years,	5
3 months,	1	12 years,	9
4 months,	1	13 years,	4
5 months,	2	14 years,	11
6 months,	2	15 years,	2
7 months,	2	16 years,	3
8 months,	5	17 years,	2
9 months,	3	18 years,	1
10 months,	3	19 years,	7
11 months,	6	20 years,	2
12 months,	16	21 years,	4
13 months,	5	22 years,	5
14 months,	11	23 years,	3
15 months,	3	25 years,	3
16 months,	12	27 years,	1
17 months,	5	28 years,	1
18 months,	22	29 years,	2
19 months,	6	30 years,	2
20 months,	12	33 years,	2
21 months,	12	34 years,	1
22 months,	5	35 years,	2
2 years,	121	40 years,	2
3 years,	90	41 years,	1
4 years,	60	62 years,	1
5 years,	32	72 years,	1
6 years,	31	Not stated,	13
7 years,	30		
8 years,	9		628
9 years,	13		

By Age Periods.

	Boston.	Per Cent.	New York.[1]
From birth to 12 months, inclusive,	44	7.15	62
1 year old,	93	–	221
2 years old,	121	–	180
3 years old,	90	–	106
4 years old,	60	–	63
5 years old,	32	71.54	28
	440	–	–
6 to 10 years, inclusive,	98	87.48	47
	538	–	–
11 to 20 years, inclusive,	46	94.96	19
	584	–	–
21 to 30 years, inclusive,	21	–	2
31 to 72 years, inclusive,	10	–	1
Not stated,	13	–	23
	628	–	752

[1] For purposes of comparison the New York figures are included.

Mortality.

The average total death-rate in 628 cases was 8 per cent. The mortality was greatest over ten years of age, reaching 20 per cent. in that period. Under one year the mortality was also high — 16 per cent.; between the ages of one and ten being lowest — 4 per cent.

Mortality by Age.

Age.	Cases.	Deaths.	Mortality (Per Cent.).
Under 1 year,	44	7	16
1 to 10 years,	494	20	4
Over 10 years,	77	16	20
Not stated,	13	8	–
Total,	628	51	–
Average mortality,	–	–	8

Early Symptoms.

Cases, 150. Cases not stated, 3.

Symptoms reported in 147 cases: fever, 132; pain, 110; tenderness, 108; vomiting, 67; constipation, 72; retraction of head, 60; diarrhœa, 38; headache, 33; delirium, 15; anorexia, 15; irritability, 24; stupor and restlessness, 14; malaria, 9; nausea, 18; convulsions, 4; twitchings, 3; cough, 8; dyspnea, 4; sore throat, 8; numbness, 3; chills, 2; weakness, 1; coma, 2; abdominal distention, 7; pain in abdomen, 1; jaundice, 1; vertigo, 2; double vision, 2; difficulty or inability to swallow, 4; difficulty in articulation, 2; gastro-intestinal upset, 2; diaphragmatic breathing, 1; coryza, 1.

Six cases had skin eruptions; 1, measles and mumps; 1, whooping cough; 1, malaria.

Details of Digestive Disturbances connected with Attack.

	Cases.
(*a*) Not stated,	9
(*b*) Having no digestive disturbance,	15
(*c*) With digestive disturbance, tabulated as follows: —	
(1) Preceding attack: —	
Indigestion or stomach "upset,"	4
Nausea and vomiting,	37
Constipation,	31
Colic,	2
Diarrhœa,	12
Mucus in stools,	2

	Cases.
(2) Accompanying attack: —	
Indigestion (indefinite),	3
Nausea and vomiting,	51
Constipation,	55
Colic,	8
Diarrhœa,	24
Mucus in stools,	1
(3) Following attack: —	
Nausea and vomiting,	4
Constipation,	37
Colic,	2
Diarrhœa,	10
Mucus in stools,	2

Disturbances of Intestines during Attack.

	Cases.
No disturbance in	53
Constipation,	63
Diarrhœa,	22
Involuntary defecation,	4
Constipation, later diarrhœa,	4
Diarrhœa, later constipation,	4
	150

Disturbances of Bladder during Attack.

	Cases
No disturbance,	114
Retention,	23
Frequent micturition,	3
Incontinence,	9
Retention, later incontinence,	1
	150

Pain and Tenderness.

The frequency of pain and tenderness, sometimes local, sometimes pretty general, is not sufficiently regarded as an early and persistent symptom. The accompanying table is presented to emphasize the point that it occurred in 420 and was absent only in 82 out of 502 cases in which its presence or absence was noted: —

	Cases.
Pain or tenderness was present in	420
Pain or tenderness was absent in	82
Pain or tenderness not stated in	126
	628

The pain or tenderness lasted: —

	Cases.
No pain,	82
One day or less,	7
Two days,	16
Three days,	22
Four days,	11
Five days,	10
Six days,	3
A few days,	13
One week,	47
One to two weeks,	75
Two to three weeks,	36
Three to four weeks,	26
One to two months,	28
Two to three months,	5
Several months,	3
Until death,	11
Present when report was made,	107
Not stated,	126
	628

Appearance of Paralysis in Days after Onset of Fever.

	Cases.
Same day,	30
One day,	36
Two days,	27
Three days,	23
Four days,	14
Five days,	7
Six days,	5
Seven days,	1
Eight days,	1
Eleven days,	1
Twelve days,	1
Fourteen days,	2
Sixteen days,	1
Not known, fatal,	1
	150

Distribution of Paralysis.

The distribution of the paralysis is shown in the table. It is interesting to note that when one arm and leg are paralyzed a hemiplegic distribution is more common than a crossed paralysis, and the frequency of facial paralysis is worthy of note.

	Cases.
One leg only,	192
Both legs only,	151
One arm only,	32
Both arms only,	11
One arm and leg, same side,	57
One arm and leg, opposite sides,	17
Both legs and one arm,	38
Both arms and one leg,	6
Both arms and both legs,	82
Not stated,	12
Back,	83
Abdomen,	37
Face,	8
Right face,	16
Left face,	10

Prognosis.

Recovery Rate in 628 Cases.

In answer to the question, "Has paralysis entirely disappeared?" the replies were as follows: —

	Cases.
Yes (10.8 per cent.),	62
No,	404
Partially,	61
Death,	51
Not stated,	50
	628

This table is intended to emphasize the fact that what appears to be recovery in the eyes of the family physician occurs more frequently than is generally supposed, 10 per cent. of such cases being reported. This led to a closer investigation of the recoveries in the 150 cases carefully investigated, and it was reported by the investigators that 25 of these (16.7 per cent.) had wholly recovered. This report was not accepted and the investigators were sent again to these children, and each child was stripped naked and the separate movements of ankle, knee, hip, spine, abdomen and arms were separately tested. From this careful examination it is sure that 25 children out of 150 have recovered since the disease in 1909. The following tables deal only with these 25 cases.

Age of 25 Recovered Cases.

So far as one may generalize from these few cases, it would seem that the average age of the children was higher than in the cases in general.

Age.	Cases.	Age.	Cases.
1 year,	3	9 years,	1
2 years,	1	10 years,	1
3 years,	5	14 years,	1
4 years,	5	21 years,	1
5 years,	2		
6 years,	4		25
7 years,	1		

Onset.

The character of the onset was mild in 6, moderate in 17 and severe in 2.

Evidence of Paralysis.

The presence of paralysis in the beginning is vouched for by the attending physician in 23 cases and by the family in 2, and the distribution of paralysis was on the whole fairly extensive, as shown by the table.

Extent of Paralysis in 25 Recovered Cases.

	Cases.
One thigh and leg,	4
Both thighs and legs,	8
Both thighs,	1
One leg,	2
One arm,	1
One leg, arm and back,	1
One leg and back,	1
One thigh, leg, arm and forearm,	1
One arm, forearm and cervical region,	1
Cervical region,	4
Indefinite staggering gait,	1
	25

The extent of the paralysis, therefore, did not differ essentially from that of the whole group presented above.

Duration of Paralysis in 25 Recovered Cases.

Time.	Cases.	Time.	Cases.
3 days,	2	8 weeks,	8
1 week,	3	12 weeks,	4
2 weeks,	3		
3 weeks,	2		25
4 weeks,	3		

Tenderness in Recovered Children.

It was thought that such cases being slighter might show less tenderness in the acute stage, but the tenderness was about as frequent as in the severer cases.

Pain or tenderness in the acute attack existed in 19 out of 25 recovered cases.

Duration of Tenderness.	Cases.	Duration of Tenderness.	Cases.
2 days,	1	3 weeks,	1
3 days,	1	4 weeks,	3
7 days,	6	6 weeks,	1
10 days,	1	8 weeks,	2
2 weeks,	2	12 weeks,	1

The statement may, therefore, be made that in the whole group of 628 cases, 10.8 per cent. were reported as wholly recovered; that in the smaller group of 150 cases, 16.7 per cent. are known to have recovered; and that a study of character of onset, distribution and tenderness in these cases gives no means of distinguishing them from other cases at the time of the attack.

Prevention.

In the matter of prevention of the disease in Massachusetts, in November, 1909, it was made one of the notifiable diseases, like scarlet fever, etc. In a recent circular addressed to physicians it has been advised by the Board that such cases should be quarantined, and that urine, stools and sputum should be disinfected, and we have called attention to the existence of abortive cases as probable sources of contagion.[1]

[1] In a recent communication, Flexner and Lewis report that a 1 per cent. solution of peroxide of hydrogen in perhydrol has been found to destroy the virus. In view of their belief that the entrance of the virus is probably by the respiratory tract, the use of a nasal douche of this character would seem advisable.

CONCLUSIONS.

These data are presented as a report of progress in an investigation which will be continued, and no conclusions are drawn from them.

That the effort of the State Board meets with general approval is shown by the fact that the following resolution was adopted in Washington, on May 5, 1910, by the American Orthopedic Association and the American Pediatric Society: —

It having been shown by recent epidemics, and investigations connected with the same, that epidemic infantile spinal paralysis is an infectious, communicable disease which has a mortality of from 5 per cent. to 20 per cent., and that 75 per cent. or more of the patients surviving are permanently crippled, State Boards of Health and other health authorities are urged to adopt the same or similar measures as already adopted and enforced in Massachusetts for ascertaining the modes of origin and manner of distribution of the disease, with a view to controlling and limiting the spread of so serious an affection.

What the course of the disease may be in 1910 in Massachusetts cannot be predicted. It would be expected from the history of the disease that a year of comparative immunity in the State as a whole would follow the great prevalence of the disease in 1909, and it is, therefore, disappointing to find 22 cases reported in the first five months of 1910, as against 15 cases for the same five months in 1909. Whether this means merely an increased attention on the part of the profession, or a really increased prevalence of the disease, time alone will show.

The object of the inquiry in 1910 will be twofold.

First, the formulation and classification of early symptoms and types of the disease, with especial reference to early diagnosis; and, second, a study of the conditions under which contagion seems to occur, with a continued search as to the mode of entry of the virus into the body.

The medical profession must remember that the Board of Health acts only as the agent of the profession in assembling the data provided by them, and depends on them for the same willing co-operation that it has met and is profoundly grateful for in the past.

The report for 1910 will be what the profession makes it, and the Board is anxious not only for the prompt and full report of typical cases, but also for notification of suspicious and atypical cases, which are possibly of the abortive type and a most important link in the chain of evidence.

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INFANTILE PARALYSIS AS OBSERVED IN HEALTH DISTRICT No. 15 DURING 1909.[1]

During 1909 there were 82 cases of anterior poliomyelitis in District No. 15 (Berkshire County), 2 cases on the eastern border of the district, in Plainfield, and 2 over the line in New York State, in Austerlitz, making a total of 86 cases included in this report.

Appearance of Cases.

January and February were the only months in the year when there were no cases. Sixty-eight cases, over 79 per cent., occurred during August, September and October.

Location of Cases.

With the exception of 2 cases in Plainfield, 1 in Savoy, 1 in Richmond and 2 in Austerlitz, 6 in all, the remaining 80 cases were in the central part of the county, running north and south, following for the most part very closely the course of the streams, along which lie also the principal means of communication, including highways, electric railways and steam cars.

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[1] Lyman A. Jones, M.D., State Inspector of Health.

Cases by Towns.

City or Town.	Population.	Number of Cases.
Adams,	12,548	19
Clarksburg,	1,200	1
Egremont,	721	1
Great Barrington,	6,152	19
Lee,	4,000	2
Lenox,	3,058	7
North Adams,	23,000	11
Pittsfield,	30,000	17
Richmond,	600	1
Savoy,	549	1
Sheffield,	1,728	1
Stockbridge,	2,022	2
Plainfield,	382	2
Austerlitz, N. Y.,	–	2

APPEARANCE OF CASES CHRONOLOGICALLY.

A table giving the occurrence of cases in chronological order shows that cases appeared impartially through the central portion of the county all through the season, except that in Great Barrington there were 19 cases, all of which appeared between September 3 and October 7, inclusive.

The number of cases in the family, and the day of illness upon which the paralysis appeared, are given below.

Number of Cases in a Family.

	Families.	Cases.
One case,	72	72
Two cases,	7	14
	79	86

Appearance of Paralysis.

Day of Disease.	Number of Cases.	Day of Disease.	Number of Cases.
First,	8	Eighth,	4
Second,	16	Ninth,	2
Third,	14	Fourteenth,	2
Fourth,	17	Not stated,	11
Fifth,	5		
Sixth,	4		86
Seventh,	3		

POSSIBILITY OF THE DISEASE BEING SPREAD BY PHYSICIANS.

The 86 cases were seen or attended by 40 physicians, the number of cases to each physician being as follows: —

22 physicians attended 1 case each.
8 physicians attended 2 cases each.
5 physicians attended 3 cases each.
2 physicians attended 5 cases each.
1 physician attended 6 cases.
1 physician attended 7 cases.
1 physician attended 10 cases.

In no instance was any evidence discovered to suggest that the disease had been brought into a home or transferred elsewhere by the physician in attendance. Nor were there any cases in physicians' families.

There were 6 fatal cases. There were 4 abortive cases (59, 62, 69 and 79), while 2 other possible abortive cases, not included in the summary, are mentioned in connection with cases 1 and 18.

Aside from the instances where a second case in a family developed at an interval of from three to fifteen days after the initial case, and where the primary case may possibly be regarded as the source of infection; and aside from two instances to be mentioned, there is very little evidence pointing toward the active contagiousness of the disease in Berkshire County in 1909.

While in many places facts have accumulated indicating that in some localities, at some times, the disease is readily communicated from one person to another, and that it may perchance be carried by a third person, this series of cases, as well as the series in Western Massachusetts in 1908, studied by Emerson, leads to the conclusion that the contagiousness of the disease varies greatly in different groups of cases, even though the various groups in a given locality occur at the same period and are situated comparatively near each other.

For example, the cases in the North Adams group afford no known points of contact with each other. The same is largely true for the cases in the Pittsfield group.

The two instances particularly suggestive of contagion are given in detail in the summaries for Adams and Great Barrington (*q. v.*).

In the former, two children, giving a positive history of close personal contact (kissing) with a child already ill with the disease, promptly developed the disease themselves, and one died.

In Great Barrington, out of 19 cases within a period of thirty-four days 13 were associated with one school, 5 pupils themselves contracting

the disease, the remaining cases having brothers, sisters or other relatives, with whom they came in close contact, in attendance at the school. The 5 cases in pupils of the school were confined to the second, third and fourth grades, where the contact might readily be the more intimate on account of the younger age of the children in attendance.

These two instances are of especial interest because of the possibility of the infection entering the system through the nasopharyngeal spaces.

That the virulence of the infection varies greatly is further evidenced by the fact that in most instances but 1 case occurred in a family, that no cases occurred among the friends or relatives of a given case, and that, too, notwithstanding the most intimate contact, such as occupying the same room, sleeping in the same bed, assisting in caring for or entertaining the patient by brothers and sisters or neighboring children, and the entire absence of any attempt at isolation or quarantine.

If, as has been maintained by some, every case is to be traced to direct or vague indirect contact with some preceding case, it becomes exceedingly difficult to account for the immunity of the much larger number who are in close to intimate contact with the patient.

A map of the cases emphasizes what has been pointed out previously, that with a half dozen exceptions the cases are located in the valley, close to the streams, the travelled highways and the steam and electric railway lines.

Under the circumstances it seems reasonable to isolate the patient ill with acute anterior poliomyelitis until the acute stage is past, and to urge physicians and families to be suspicious of acute attacks of disturbances of digestion, accompanied by fever and pain, particularly if at the time there are other cases of the disease known in the community.

Summary, North Adams and Vicinity.

In North Adams in March occurred a sporadic case, the first of the year. The remaining cases, 11 in all, occurred in May (1 case), September 15 to 29 (4 cases), and October 4 to 20 (5 cases).

One case taken ill March 2, involving eventually the whole body, was fatal twelve days later from paralysis of respiration.

In each instance there was but 1 case in the family, unless the brother of the Clarksburg case (case 1), taken ill two days later with fever, vomiting and general achiness, be regarded as an abortive case.

It is doubtful if the sister of case 7, ill for two days at the same time with fever, is to be considered as an abortive case.

Location.

Two cases were within one-half to one-quarter mile of the North Branch of the Hoosick River, while 10 were close to or comparatively near the Hoosick River or its North or South Branches.

With the exception of case 7, September 29, cases 10 and 11, October 20, which were comparatively near each other, the cases were widely scattered.

So far as school attendance was concerned, but 4 of the children attended school (cases 1, 6, 8 and 10), and no 2 cases occurred in children attending the same school; and in but one instance (case 6, taken ill September 26, and case 9, taken ill October 14) were other children in the same family attending the same school, though even here they were in different grades.

Ten of the cases were attended by as many different physicians. One physician had 2 cases (case 1, October 4, case 8, October 11), but he did not attend the second family until called to see the child already ill.

There were no cases in physicians' families, though in four of them there are children.

With the possible exception of the abortive case in the family of case 1, above mentioned, none of the cases appear to have been associated with each other in any known manner.

In this connection, however, 5 cases (case 2A, May; case 3, August 13; case 4, September 15; case 5, September 25; case 11, October 20) are located on streets through which electric cars run. These same streets are also used somewhat by touring automobiles.

None of the cases are near railroad stations, and but 3 (cases 2A, 3 and 5) are at all near the railroad tracks.

Case 1.

C. R., six years, Clarksburg. Dr. F. D. Stafford, North Adams. Apparently an isolated case. Was not away from home except in North Adams several times during the week beginning September 6 (Old Home Week). After complaining of being tired for one week, taken ill October 4 with nervousness, fever (103°), retraction of the head and pain in the legs. On October 6, paralysis in both legs, more marked in the left. October 20, paralysis still present in the left leg.

Five other children in the family; they attend school in Clarksburg.

Abortive Case.

The brother Charles, eight years, was taken ill on October 6, after eating choke cherries, as his brother had done, with fever, vomiting, nervousness and general achiness. No paralysis.

Case 2.

T. G., one year, 329 River Street. Dr. W. F. McGrath, North Adams. An isolated case. Taken ill March 2 with fever and dullness. On following day the fever continued, vomiting and convulsions occurred, though the patient appeared better. The convulsions were repeated later, and according to the physician there was paralysis of the whole body, especially of the muscles of the chest and neck. Fatal on March 14, from paralysis of respiration.

One other child in the family; none in school.

Case 2A.

B. R., 23 West Main Street, North Adams. Dr. C. W. Wright, North Adams, first saw case; later, Dr. J. H. A. Matte. Without preliminary symptoms, except a slight cold for two or three days, patient suddenly felt that the left side of the face was stiff and queer, and on the following day there was complete paralysis of the left side of the face. This was probably in May. Though the condition is improved, the paralysis is still well marked (Feb. 19, 1910).

Case 3.

C. C., ten months, 183 State Street. Dr. J. H. A. Matte, North Adams. Had been having whooping cough during the preceding five weeks. Taken ill August 13, at which time the whole of the right arm was found paralyzed. September 21, paralysis still present from the shoulder to the elbow.

One other child in the family; none in school.

Case 4.

L. R., three years, 95 Beaver Street. Dr. N. M. Crofts, North Adams. With no symptoms preceding except a three-days cold, taken ill on September 15 with fever. On September 18, paralysis appeared of the right side of the face. Still present December 16.

Two other children in the family; none in school.

A sixteen-year-old girl, patient's cousin on mother's side, had paralysis at fourteen months of age, and is still unable to walk. She often visits this family.

Case 5.

E. M., three years, 1527 West Main Street, Blackinton. Dr. J. B. Hull, Williamstown. Early in August fell down stairs. No apparent injury. A week later had a prolapse of the rectum, which required replacing by a physician. During the last half of August was in Winchendon, Mass. At the end of August, on her return from Winchendon, had an attack of bowel disturbance, accompanied with fever, vomiting and diarrhœa. About September 25 became feverish (102°), irritable, restless, with pain in the back and legs, followed by vomiting and diarrhœa. About October 1 paralysis appeared in both legs. Still present, especially in the left leg (October 14).

One other child in the family, attending Blackinton School, grade 2.

Query: Did this case really begin at the end of August, and were the later symptoms in September a recurrence?

Case 6.

R. T., one year, 27 Harris Street. Dr. M. M. Brown, North Adams. During the early part of July had bowel trouble for three or four weeks. Taken ill with fever on September 26, and on following day the right arm was paralyzed.

Six other children in family; 1 attending Veazie School, grade 2, and 1 attending Johnson School, grade 5.

Case 7.

G. P., nineteen months, 60 Cliff Street. Dr. W. A. Brosseau, North Adams. Previously well. Fever on September 29. Very little pain. Constipated. On October 2, paralysis in right leg.

Five other children in the family, 2 of whom attend the Notre Dame School, grades 2 and 5.

At the time this child was taken ill a sister had a fever for two days. No other symptoms. It seems unlikely that this was an abortive case.

Case 8.

J. M., seven years, 57 Kemp Avenue. Dr. F. D. Stafford, North Adams. Taken ill October 11, with fever, headache, vomiting and pain back of eyes and in back of neck. Paralysis in right side of the face on October 13.

No other children in the family. The patient attends Houghton School, grade 3.

Case 9.

G. M., two years, 45 Williams Street. Dr. O. J. Brown, North Adams. For two weeks preceding, fingers and eyes seemed sore. On October 14, fever, vomited, did not seem to see well, and had been very quiet for two days before. On October 18 there was retention of the urine, and paralysis of both arms and both legs. Could not hold the head up.

Three other children in household; 1 attends the Johnson School, grade 7, and one attends the Drury School. Four cousins, living on Loftus Street, were frequent visitors during the illness, and they attend the Veazie School, kindergarten and grade 1.

Case 10.

J. M., six years, 14 Montgomery Street. Dr. J. F. C. Forster, North Adams. Sent home from school on October 19 on account of a headache. *Nosebleed* that evening for nearly two hours. On following day there was slight paralysis of the left side of the face, gradually becoming more pronounced during the succeeding two days.

Four other children in family. Patient returned to school at St. Joseph's, grade 1, on October 22 or 23.

Case 11.

R. T., two and one half years, 132 Union Street. Dr. A. A. Harper, North Adams. No fever. Illness began October 20 with vomiting, pain in both legs and in the right arm. Paralysis on same date in both legs and in right arm.

Two other children in the family; none in school.

Summary, Adams and Vicinity.

In Adams and vicinity there were 22 cases (Adams 19, Savoy 1, Plainfield 2).

Savoy and Plainfield cases are included in this group because Adams is the natural trading center and source of supplies.

The first cases in Adams were 3 which occurred at the end of the month on the 27th and the 29th of July. On August 3 occurred the case in Savoy, while in Adams there were cases on the 8th, 20th and 30th of the month. In Adams there were cases September 8, 18 (2) and 26.

Late in the month, September 22 and 29, occurred the Plainfield cases, both in the same family.

In October, on the 2d, 3d and 21st, occurred further cases in Adams. Between November 2 and 5 (about) there were 3 cases, and the last were on December 4 and 7, both in the same family.

Paralysis, more or less severe, was present in every case but 1 (case 28).

One case, taken ill on July 29, with paralysis of both legs and throat on August 1, was fatal on August 3, from paralysis of respiration (case 13).

In three instances there were 2 cases in the same family. In all the remaining instances but a single member of the household was afflicted.

An infant of nineteen months on High Street, was taken ill on August 20, with paralysis of the right leg on August 26 (case 18).

On August 31 a two-year-old baby living upstairs in the same house was taken with fever, diarrhœa and loss of appetite. It recovered within a few days without further symptoms. There had been some communication back and forth between the two families, and possibly this should be regarded as an abortive case.

All of the Adams cases were practically in the valley near the north and south center of the town, and near or comparatively near the South Branch of the Hoosick River. Those farther away were in every instance near some small brook feeding into the branch of the river just mentioned.

With reference to the town itself two or possibly three groups of cases may be distinguished.

One group is at the south part of the town, where the first cases occurred. Between July 27 and September 18 there were 8 cases, with 2 more somewhat at one side early in December, both in the same family.

At the north end of the town, near Renfrew, was another group of 4 cases, 3 in two adjoining tenements, between September 18 and November 5.

The 5 remaining cases, more or less scattered, were in the central portion of the town, on August 7, 30, October 2, 21, and November 2, respectively.

In Adams, again, school attendance, with one possible exception, seems to have had no part in the spread of the disease.

Two boys who attended the first grade of the Liberty Street School were taken ill on October 21 (case 23) and November 2 (case 24), respectively. The former child was out of school during the week of October 25, except for a half day on October 26. He was in attendance from November 1 to 4, inclusive, and has not been in school since. The second boy left on November 2, so that there was possible contact on October 26 and again on November 1.

Aside from these two none of the patients attended school. Nor were there any instances where other children in the same family with the patient attended the same school, except that on September 13 other children from four families where the disease existed earlier in the summer began attendance at the Commercial Street School. No new cases developed here, however.

The 22 cases were attended by 7 different physicians. In no instance had an interval of less than a month intervened between the time the physician last called at the house and the time he was called to attend the patient already ill with paralysis.

There were no cases in the families of physicians, though in four or five of the families there are children.

Possible evidences of contagion are shown in the following instances: —

The first case appeared in the south part of the town, in a boy three years of age, on July 27 (case 12). He played much with his cousin, a three-year-old-girl, who lived on an adjoining street, and kissed her on the day he became ill. She also visited him daily, and probably kissed him until she herself became ill, two days later, on July 29 (case 13). This case was fatal on August 3.

This child played frequently with a little girl of two and a half years, living two doors away, who was taken ill on August 8 (case 16). In this case there is a history of the child having kissed the preceding (case 13) after she was taken ill. The mother of the third case also visited the house of the second case after the patient's decease, and viewed the remains, on August 4 or 5.

These 3 cases are of special interest in view of the recent announcement of Dr. Flexner showing that the secretions of the nasal passages contain the infecting material.[1]

The remaining cases in the immediate neighborhood afforded no history which would indicate the source of the disease.

Of the group of 4 cases at the north end of the town, 3 appear to have been somewhat in contact.

A boy of five years (case 17A), living in a six-tenement block, was taken ill on or about September 18. A brother, seventeen years old, became ill on October 3 (case 17B).

An infant of twenty-one months (case 25A), living in the adjoining tenement, was taken ill November 5 or shortly after. This patient's mother visited in the adjoining tenement during the illness of the older brother, and the younger children played more or less with the younger brother (case 17A).

There is no evidence of the association of these cases with others in the town.

The possible contact of 2 cases in the scattered group in the center of the town has already been indicated in the paragraph on schools (cases 23 and 24).

There is nothing to indicate the source of the disease in cases 26 and 27, a brother of four years and a sister of twenty-one months, taken ill on December 4 and 7, respectively, except that if the incubation period in the majority of cases is from two to four days, as suggested by Wickman, it would seem reasonable to conclude that the sister received her infection from the brother.

With reference to the cases 29 and 30, daughter and father, in Plainfield, the following is of interest: —

The daughter, three years, became ill in the evening of September 22, after her return from Adams, where she had been during the day, on a trading trip with her mother. There was no known contact with other cases. This was the first time she or her mother had been away from home for two or three months.

At this same time, September 22, her father was ailing, but he did not really give up till September 29. Earlier in the month he had driven some horses to Springfield, spending four days in the round trip. So far as known he did not come in contact with other cases.

This man's father, who lived with him, died from heart disease on August 16. The minister from the adjoining town, who conducted the funeral two or three days later, had a child ill at the time with infantile paralysis. If this can be considered the source of infection, the incubation period was much prolonged.

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[1] Jour. A. M. A., Feb. 12, 1910, p. 535.

Two cases (case 13, July 29, and case 16, August 8) are on streets through which electric cars pass, while 5 are located on side streets very near electric car lines.

Automobile traffic through the town follows almost entirely the line of the electric cars.

Case 12.

Boy, D., three years, 15 Elm Street, Adams. Dr. P. S. Potter, North Adams, Dr. H. B. Holmes, Adams. Taken ill July 27, with fever, intense headache, vomiting, constipation. Tried to walk, but fell. Tenderness along the spine. July 29, paralysis in both legs.

There is one other child, of six years of age. No school at this season, though the child began in the fall at the Commercial Street School, grade 1.

This patient is a cousin of the following case, A. D. (case 13). The two children played together constantly. The case 13 child *saw this patient the night he was taken ill and kissed him.* She also saw him each day till taken ill herself, on July 29, and probably kissed him. Father works at the Jacquard Mill.

Case 13.

A. D., three years, 123 Commercial Street, Adams. Dr. H. B. Holmes, Adams. About the end of June fell 9 feet; no apparent injury. About July 22, considerably frightened by an automobile. Taken ill July 29, with high fever, vomiting and considerable prostration. August 1, some retraction of the head, some paresis of both legs and paralysis of muscles of mouth. Fatal on August 3, from paralysis of respiration; for thirty hours previous to death was unable to speak.

This patient is a cousin of the above (case 12), with whom she played on the day he became ill, and kissed him that night, after he was ill. Also saw him daily till taken ill herself. Also played with case 16. There is one other younger child. Father works in the Jacquard Mill.

Case 14.

B. D., four years, 8 Pearl Street, Adams. Dr. A. K. Boom, Adams. Taken ill about July 29, with fever, vomiting and some pain (child did not want to be touched). There followed about August 1 partial paralysis of both legs; the child could not stand up, and there was some difficulty in voiding urine.

One other child, a boy of seven, in the family. Four Yankee children in the other side of the house. They do not play together much because of the difference in nationality. No school at this time. The boy now goes to the Commercial Street School, grade 1. Father works at the Berkshire Mills.

There is no information obtainable of contact with other cases. Cases 12, 13 and 16 are all near, but the mothers of all agree that this child was not acquainted with them. They all live very near each other, however.

Case 15.

S. G., fifteen months, 3 Godek Street, Adams. Dr. A. K. Boom, Adams. History previous to the appearance of the paralysis, about August 7, unobtainable. The family are ignorant Poles, and even with an interpreter can furnish no satisfactory information. On August 7 both legs were paralyzed.

Taking into account the time of occurrence, the age of the patient, the nationality of the family and the location of the home, contact with other cases seems improbable.

Case 16.

D. G., two and one-half years, 127 Commercial Street, Adams. Dr. A. K. Boom, Adams. Taken ill August 8, with fever, slight stiffness of the spine and the head drawn back. On the third day vomiting. On the following day there was pain at McBurney's point, and appendicitis was suspected. On the third or fourth day, as developed later, retention of the urine occurred, only the excess from the distended bladder escaping. On the fifth day patient was removed to a hospital and operated on for a supposed intussusception of the bowel. Nothing was found except an excessively distended bladder. On August 18 appeared paralysis of both legs and the right arm, thus establishing the diagnosis.

One other child in family, attending Commercial Street School, since opened in September. Father is a fern dealer.

This child played much with case 13, and on the day he was taken ill, July 29, saw him and kissed him. Mrs. G. visited the D. family on August 4 or 5, just before the funeral, to carry some flowers, and was in the room to see the body.

Case 17.

F. O., four years, 1 Plunkett's Lane, Adams. Dr. J. H. Choquette, Adams. Taken ill on September 18 with fever, and that same night the leg (left) was paralyzed. On September 19 vomited several times. This was a mild case.

One other child in the family, younger. No school. Father works in the Jacquard Mill. The visit of the family to Plainfield in August was not near any known case on the mountain.

Case 17A.

R. S., five years, 74 Friend Street, Adams. Dr. A. Desrocher, Adams. During July and August had whooping cough. The sister next younger also had the same disease, and died from it on August 16. Taken ill about September 18, with headache, fever, vomiting and convulsions. Retraction of the head was present, and for three days he was delirious. About September 21 both legs were paralyzed. Improvement began after two weeks.

There are 5 other children; none in school. A brother works in the cloth room at the No. 4 Berkshire Mill. The father of case 25A (early in November) also worked here.

An older brother (see following case, 17B) was taken ill with this disease on October 3.

A child in the adjoining tenement was taken ill early in November (see case 25A).

Case 17B.

C. S., seventeen years, 74 Friend Street, Adams. Dr. A. Desrocher, Adams. Without previous illness, taken ill on October 3 with fever, headache, dizziness and pain in the back. Retraction of the head present. On October 10, paralysis of left leg and the right arm. For about one week not able to get about.

At present is at work as spare hand in the main mill of the Renfrew Manufacturing Company. The left leg is smaller and also weaker than the right at present (Feb. 15, 1910).

This boy is brother of the foregoing (case 17A), and it would seem probable that this was a case of contact infection from the brother. During the illness of this patient the mother of a child next door (case 25A) came to call, and the children of both families were together more or less.

Case 18.

W. S. G., nineteen months, 10 High Street, Adams. Dr. J. A. Quest, Adams. Taken ill on August 20, with fever. On 21st seemed better; on 23d cried all day; on 24th perspired and slept much of the time. The inclination to sleep continued nearly one week. On August 26th the right leg was paralyzed.

An only child. Father works in Jacquard Mill, where father of case 12, taken ill July 27, works. Before and during the illness, children living upstairs, two, four and nine years of age, played with this baby, and soon after, possibly about August 31, the two-year-old boy was taken ill (see following case).

Possible Abortive Case.

E. G., two years, 10 High Street, Adams. Dr. J. A. Quest, Adams, who made one visit as society physician, and made no record of it. Hence the uncertainty of the date of the illness. About August 31 taken ill with fever, diarrhœa, loss of appetite. This was on a Friday or a Saturday. When sent for the physician was out of town, and did not come till the following Tuesday. Only one visit. There was some question as to circumcision, which was done some time in September. There was no paralysis, and no further symptoms. In October the child again had fever, vomiting and was dull. Seen by physician three times.

This woman keeps about 15 chickens. An indefinite time before case 18 was taken ill 2 of the chickens died, one about two weeks after the other. The deaths were sudden, and the chickens were previously well so far as known.

Case 19.

I. C., four years, 3 Gilliad Street, Adams. Dr. A. K. Boom, Adams. August 30 taken ill with fever and vomiting. On September 1, paralysis both legs and right arm. Constipated.

One other child, ten years, at French parochial school, grade 3. Father works at L. L. Brown Paper Company, lower mill. Mother works at spinning, Berkshire Mill No. 3. The children in this family had no contact with a small child upstairs, though they now stay there while the parents are at work.

Case 20.

R. P., two years, 16 Temple Street, Adams. Dr. J. H. Choquette, Adams. Illness began with fever, slight retraction of head and pain in neck on September 8, followed by headache and paralysis of right arm on September 10.

There are 2 other children, older; 1 in school at Commercial Street, grade 2, though school did not begin till September 13. The father works as a trimmer in the upper mill of the L. L. Brown Paper Company.

Case 21.

P. P., three years, 143 Bellevue Avenue, Adams. Dr. A. K. Boom, Adams. On September 26 taken ill with fever, tenderness in the legs and some pain in the neck. Constipation. On September 28, paralysis in both legs. Retention of urine for twenty-four to thirty-six hours.

One other child, older, attending the Maple Grove School, grade 2. Father works for Renfrew Manufacturing Company as a painter. No known contact with other cases.

Case 22.

J. F. N., four years, 48 Maple Street, Adams. Dr. J. H. Choquette, Adams. In April had what attending physician said was eczema, but what Dr. Boom, who was called in, said was scarlet fever. Child peeled. There was subsequent weakness in walking. Just two weeks before J. was taken ill, the father was sick with grippe, and consulted the same physician at the *latter's office*. The physician was not in the house for at least a month before this illness began. Illness began October 22, with fever and headache. Vomited once on following day, at which time appeared paralysis of the right arm. There was also some pain in the neck and tenderness in the right arm. There was also a mild tonsilitis at this time. Constipated.

There are 2 younger children; none in school. Father employed as clerk in drug store. There are 2 French children in the family downstairs.

Case 23.

R. D., five years, 53 Spring Street, Adams. Dr. A. Desrocher, Adams. Illness began October 21, with fever, some pain and tenderness in the legs. On October 24 woke crying, and said he could not move. Brought downstairs and dressed, but was inclined to lie in a chair for this and the follow-

ing days. On October 25 woke crying again, and said his "legs were gone." Later he got about by placing his hands on a chair and hopping. This continued for ten or twelve days, and disappeared gradually by the end of a month.

There are 2 younger children. This boy attended school at Liberty Street, grade 1, from which room there was another case (24) on November 2.

The school record of attendance shows as follows: this boy was first out on October 25, whole day; was in in the afternoon of the 26th of October, and then out rest of the week. The following week was in from November 1 to 4, inclusive, then permanently out. From which the inference is that the dates as to the onset of the illness are not entirely accurate, though the facts stated are correct.

Early in August he was on a farm in Savoy, near the Harris farm (see case 28), whence he returned at the end of August. During the stay in the country he visited the Harris farm and saw the patient there after she had been taken ill. The interval before his own illness is too long to make this likely as the source of his infection. This boy frequently played at his father's livery stable, where he may have come in contact with the grandfather of case 20 (taken ill September 8), though the interval here seems long to trace the infection thence. The grandfather and case 20 were in frequent contact.

Case 24.

J. C., six years, 17 Randall Street, Adams. Dr. A. J. Bond, Adams. Taken ill November 2, with fever, possibly some headache. Paralysis of both legs on November 4.

Attended Liberty Street School, grade 1, where he was in possible contact with case 23 on November 1, and during the preceding week. No other cases occurred in this school.

There are 5 other children, 2 of whom attend the same school, grades 4 and 9. They lost no time from school during the whole of the brother's illness. Father is a master plumber.

Case 25.

F. B., twenty-seven months, 18 Pine Street, Adams. Dr. A. K. Boom, Adams. November 4, taken ill with fever and slight tenderness in left leg. On November 5, paralysis in lower part of left leg.

One younger child. Father, mule spinner, Berkshire Mill No. 4. No known contact with other cases. An English family, here only a few months, not acquainted much as yet.

Case 25A.

H. W., twenty-one months, 76 Friend Street, Adams. Dr. H. B. Holmes, Adams. During late summer and early fall had stomach trouble. Taken ill after November 5, with fever and vomiting. Constipated. No special pain. Two weeks later, about November 19, had paralysis of both legs. Still (Feb. 15, 1910) unable to walk.

Six other children in family, 2 in Renfrew School, grades 4 and 5. Possible contact with case 17B, next door, through the children who played together. Father works in cloth room, Mill No. 4, Berkshire Mills.

Case 26.

A. T., four years, 13 Enterprise Street, Adams. Dr. J. H. Choquette, Adams. December 4, fever (104°), delirious and pain in the neck and right hip and leg. Vomiting. Constipation. December 5, paralysis of right leg.

Brother of case 27.

Case 27.

C. T., twenty-one months, 13 Enterprise Street. Dr. J. H. Choquette, Adams. Taken ill December 7, with fever (102°), slight retraction of head, some pain in the back and legs.

December 10, paralysis of both legs and the right arm.

Sister of case 26.

Ten other children, older, in the family at home. Some attend the parochial school and some work, but there is no known contact, either direct or indirect, between these cases and others. This is probably a contact infection from the first case in the family.

Case 28.

E. H., five years, Brier, Savoy. Dr. W. W. Pascoe, Savoy. Taken ill August 1, and on August 3 had fever, vomiting, slight sore throat, pain and tenderness in the leg. No marked paralysis, but rather weakness in legs.

A brother, fourteen years, had a similar attack at five years of age. Now has marked atrophy of left leg. No known contact with other cases previously (see case 23).

Case 29.

M. J., three years, Plainfield. Dr. W. W. Pascoe, Savoy. Entirely well, living remote from neighbors, was taken ill on September 22, with fever, delirium and pain in the back. Also had *nosebleed*, vomiting and diarrhœa. On day of onset had made a trip to Adams with her mother, but so far as known came in no contact with any Adams case. On September 26, paralysis of both legs and some difficulty in voiding urine.

The following case is the child's father.

Case 30.

H. J., thirty-three years, Plainfield. Dr. W. W. Pascoe, Savoy. This patient, father of the preceding, was ailing at the time his daughter was taken ill, or even a day or two before, but he did not give up till September 29, when he had fever, nosebleed, pain in the neck and delirium. There was retention of urine, paralysis of both legs and both arms, and partial paralysis of right side of the face. There was also disturbance of the

respiratory muscles. At the present time he is in a Springfield hospital, and is only now (December 24) beginning to move his toes.

Some time previous to the illness he drove several horses over the road to Springfield, being absent three or four days. So far as known he came in contact with no other cases. On August 16, the patient's father, who lived with him, died of heart disease. The funeral, a day or two later, was conducted by a minister from Cummington, whose child was ill at the time with infantile paralysis. Here is a possibility of infection through a third party, though the interval between exposure and onset is considerable.

Beside the daughter above mentioned, there are 2 other children in the family, one younger, one older.

Summary, Pittsfield and Vicinity.

In point of time the Pittsfield cases were much more closely grouped together than in the other communities, with the exception of Great Barrington.

Between July 14, previous to which date there was 1 case (case 31, June 22), and September 9, 14 cases occurred, 10 of which were in August. In October there were 3 cases (case 46 on October 8, case 47 on the 27th, and case 48 in Richmond on the 28th).

Paralysis, in every case involving the legs, was present.

There was but 1 case in a household. There were no suggestive abortive cases.

It is worth noting that here again the large majority of the cases are located near or comparatively near the Housatonic River.

While in one locality 6 cases occurred moderately near each other, on June 22, July 19, August 7, 14, 15 and 20 (cases 31, 34, 36, 37, 38 and 40, respectively), the fact that all of the patients were but three years old or less makes the likelihood of contact between them exceedingly slight. The history of these cases also discloses no evidence of contact.

Another group of cases, in the southern and western part of the city, on July 14, 17, August 15, 21 and 22 (cases 32, 33, 35, 39, 41 and 42, respectively), show equally slight probability of contact, except that case 35, in an Italian family, and case 39, in a Jewish family, opposite each other on the same street, may have been in indirect contact through other children in the family.

Otherwise there are no known points of contact between the different cases.

In all but three instances there are other children in the family of the patient.

That the schools had no part in occasioning the spread of the disease in Pittsfield appears from the fact that but 3 of the cases occurred after the opening of the schools, on September 7.

In but a single instance did a patient attend school (case 45, September 9).

Nor in any instance save one were children from the households of patients attending the same schools. In this instance (case 45, just mentioned, and case 46, October 8) the children were in different rooms, while the interval of nearly a month since any possible indirect contact speaks strongly against infection from this source.

The 18 cases were attended by 10 physicians. One physician attended 5 cases at an out-patient department. Another physician attended 3 cases, and 2 others 2 each.

There were no cases in physicians' families, though in three of the families there are children.

In no instance is there record of the physician having recently visited the family of the patient previously to being called to attend the patient himself.

Five of the cases (case 32 July 14, case 33 July 17, case 41 August 21, case 45 October 9, case 47 October 27) are either on the line of the electric cars, or very near on side streets leading from the car line. None of the cases, with the exception of those just mentioned and one or two others, are on streets frequented by automobile tourists.

Five or 6 of the cases are near the railroad, 1 of them near the station.

Case 31.

W. P., two and one-half years, 86 Danforth Street, Pittsfield. Dr. F. S. Coolidge, Pittsfield. Taken ill about June 22. Fever very slight, if any. There first appeared a weakness of the right leg, which gradually increased, till at the end of a fortnight there was complete paralysis of the right leg. This persisted for two weeks, and then gradually disappeared, full recovery being noted early in August.

One younger child. No school. No acquaintance with other cases. Father employed at Elmhurst Farm.

This was the first Pittsfield case.

Case 32.

L. L. S., twenty-two months, 59 Harris Street, Pittsfield. Dr. J. D. Howe, Pittsfield. Some time in June visited in Adams, on Elm Street, in the same neighborhood where later were cases in Adams. While there played in hot sun. June 12 had a burn of the right leg. Recovery. Taken ill with general gastro-intestinal symptoms on July 14. Fever was observed on July 19. Pain and tenderness were general over the whole body. There was suppression of urine on July 24, and two days later, on July 26, there was paralysis of both legs.

Second case in Pittsfield, in a totally different part of the city from the preceding.

Other children in the family. No school at this time.

Case 33.

J. E. B., seventeen months, 219 New West Street, Pittsfield. Dr. Mercer, Pittsfield. Was ailing somewhat for one or two days previous to the onset of the fever, on July 17 or 18. The doctor was called, and for a day the patient seemed better. Then the fever returned. There was retraction of the head, considerable pain and tenderness in the back. Also some general twitching on the first day. On July 21 there was paralysis of both legs. No bowel disturbance, no vomiting.

Three other children in the family. No school at this season.

Case 34.

E. G., two and one-half years, 130 Madison Avenue, Pittsfield. Dr. J. A. Langlois, later Dr. G. E. Reynolds, Pittsfield. Taken ill between July 19 and 26, feeling dull and weak in the legs. At the same time paralysis of left leg appeared.

Seven other children in family; oldest is 19 years, employed at Eaton, Crane & Pike's; others work in Musgrove Knitting Company and Stanley shops. There are 5 children in the opposite side of the house, with whom these children were in more or less contact. No school at this season. No apparent contact with other cases.

Case 35.

K. T., two years, 34 Jordan Avenue, Pittsfield. Dr. W. A. Millett, Pittsfield. Taken ill in August, with fever, stiffness of the neck and some pain in neck and legs, which continued for a week. Three days after the onset paralysis of both legs occurred, of such degree that the patient could not walk for four weeks. For two days he was unable to void.

Two other children in the family. No school. Case 39, taken ill August 15, lives on the opposite side of the street. There are children in this family as well, and notwithstanding the difference in nationality (Jews and Italians), it is conceivable that the other members of the families were in contact.

Case 36.

R. H., three years, 94 Turner Avenue, Pittsfield. Dr. G. E. Reynolds, Pittsfield. Taken ill August 7, with fever, pain in back and neck. Constipated. On August 10, paralysis of left leg, the right leg also becoming paralyzed afterwards.

One younger child in family. No school. No contact known with other cases. They are acquainted with the family of case 31 (taken ill June 22). No history of visits.

Case 37.

R. F. S., two years, 108 Linden Street, Pittsfield. Dr. Mercer, Pittsfield. Taken ill on August 14, with fever, some pain in back and neck. On August 15, paralysis of both legs. Constipated. Retraction of head for five days.

One other child in family. The patient had been to moving pictures with his mother several times. No school. Case 34 (taken ill July 19) is near by, but there is no history of contact between them.

Case 38.

D. K., twenty-two months, 52 North John Street, Pittsfield. Dr. F. S. Coolidge, Pittsfield. Taken ill about August 15, with fever, pain in neck and vomiting. On the following day there was paralysis of both legs, the left leg worse. Constipation.

Three other children in family, 2 older, 1 younger. No school. The parents are acquainted with the families of cases 39, 40 and 43, taken ill August 15, 20 and 25, respectively, two of them Jews. But with one family (case 39) there are no social or other relations, and with the others there was no contact until they were brought together after the occurrence of the disease. Father deals in junk.

Case 39.

D. H., eleven months, 37 Jordan Avenue, Pittsfield. Drs. England, Langlois, Coolidge, Pittsfield. Taken ill about August 15, with fever, drowsiness and soreness in the back. Three days later there was paralysis in both legs, the left leg worse.

Seven other children in the family. No school. Father is a junk collector. They know of no other cases except the Italian child on the opposite side of the street (case 35).

Case 40.

B. K., twenty months, 273 Dewey Avenue, Pittsfield. Dr. F. S. Coolidge, Pittsfield. The parents were informed that a few days before the onset of the illness the baby had been thrown from the baby carriage. The baby showed no evidence of it. Without preliminary symptoms the child's leg (left) was found to be paralyzed about August 15.

No known contact with other cases till some time later. There are other children in the family.

Case 41.

E. F., two years, 18 East Mill Street, Pittsfield. Dr. G. P. Hunt, Pittsfield. For two weeks, while company was in the house, the child had been out in the sun a good deal, and when she became feverish, on August 28, mother thought it might be due to exposure and fatigue. On September 2 appeared paralysis of the lower part of the left leg and the left arm.

An only child. No known contact with other cases. This house is situated close to a millpond, and on the opposite side of the pond, a short distance away, is case 32, taken ill in June.

Case 42.

A. R., three years, 194 Wendell Avenue, Pittsfield. Dr. J. B. Thomes, Pittsfield. On August 22, languid with fever (103°). On August 25, possible slight paralysis of right leg, but well-marked paralysis of left leg. Involuntary urination on the night of August 25.

One younger child in family. No school. No contact. An unusually well-appointed home, of the best class.

Case 43.

I. Y., two and one-half years, 130 Lincoln Street, Pittsfield. Dr. J. A. Langlois, Pittsfield. On August 22, a slight fall, nothing to it. Fever on August 25, accompanied with retraction of the head, stiffness of neck and pain in left hip and leg, continuing till September 1, when paralysis appeared in the right leg. For a week following the appearance of the paralysis could not retain the contents of the bowel or bladder.

Five other children in the family. No school at this time. The family moved here one week before the illness began, coming here from a concrete house on South Onota Street, near the Housatonic River, not far from Jordan Avenue (cases 35 and 39).

Case 44.

D. M., nineteen months, 6 Atlantic Avenue, Pittsfield. Dr. F. S. Coolidge, Pittsfield. August 29 had vomiting and fever, also pain in left leg. On September 1, paralysis of left leg.

No known contact with other cases. Family not acquainted with other Italian case (case 35), which is in another part of the city entirely. Two older children. No school at this time; Linden Street since. Many Italian laborers board here.

Case 45.

E. C., nine years, 13 Mellville Street, Pittsfield. Dr. G. E. Reynolds, Pittsfield. From July 29 to August 25 was with his mother in Bennington, Vt., staying in a pleasant house in the high part of the town. Returned to Pittsfield on August 25, on an electric car, and may have been chilled. Stayed a few days after his return on Curtis Terrace, Morningside, before the house here was settled. Had headache for two or three days before the onset of fever, on September 9. Vomiting for two days and delirium. Constipated. On September 10, paralysis of both legs and both arms. Still unable to use legs; arms much improved (December 2). About the middle of November had severe choking attack, of half hour's duration.

Attended Orchard Street School, grade 5.

Case 46.

C. W. N., thirty-five years, 85 Maplewood Avenue, Pittsfield. Dr. A. C. England, Pittsfield. Was in Albany on October 8, marching with the militia at the Hudson-Fulton celebration. That evening he stumbled on the street, but did not fall. There was immediately a severe pain in the left leg and shin, so that he had difficulty in returning to Pittsfield. Fever and pain continued in the leg for one week. Redness appeared over the tibia, suggesting periostitis. A low leucocyte count prevented operative treatment. With the development of paralysis in the left leg on October 15, the acute symptoms abated.

The man is a plumbing contractor, with business largely in the shop and office. There is history of contact with an old case of two or more years' standing.

Case 47.

H. C., nineteen years, 350 Wahconah Street, Pittsfield. Dr. J. A. Langlois, Pittsfield. Suddenly, on arising on morning of October 27, found he could not use the left leg as usual. Fell two or three times attempting to get about the house. Unable to raise toes. Returned to work in draughting department at Stanley shops after two days. Walked by raising the left foot high enough so as not to strike the toes.

Two other children in the family, 1 in business college, 1 in first year at high school. A case of two years' standing or more in a neighboring French family.

Case 48.

W. H. W., nineteen years, Richmond. Dr. W. W. Leavitt, Pittsfield. Had been working for two months on a farm in West Stockbridge at the time illness began. He had been ploughing for three days, when on October 28 he had backache, gradually increasing in severity during the day. He also had moderate fever, headache and some stiffness in the neck. On the following day there was paralysis of both legs, and inability to void urine. He was also unable to retain an enema. On this day he was removed to his own home in Richmond. He was stung once or twice by yellow jackets before he was taken ill.

An intimate chum of his had an attack of this same trouble two years ago. They were last together on October 18.

Summary, Lee, Lenox and Stockbridge.

There were 2 cases in Lee, 1 on October 3 (49), in South Lee, a fatal case, and the other in Lee a month later, on November 4 (50). The history of these cases does not disclose any possible contact with other cases.

There were 6 cases in Lenox. Isolated cases occurred April 12 (case

51) and June 23 (case 52), at a time when hardly another case was known in the county.

On September 22 occurred another case (53). This child, at school during June, played with case 51, ill in April, and just recently, since the opening of the schools, walking to school, had been in contact more or less with a sister of case 52 (ill in June).

Case 55, October 1, is apparently an isolated case, that of a two-year-old infant, living in the country, at New Lenox. During August the infant was with its mother in Pittsfield for one day. There was no known contact with other cases. This case is close to the electric railway, also near the railroad.

The 2 remaining cases, 56, October 17, and 57, November 15, are situated near the electric and steam car lines, near the Valley Paper Mill, at Lenox station and Lenoxdale, respectively.

The mother of the latter patient visited the preceding case, held the baby who was ill and kissed it, about a month before her own child developed the disease. The mother's sister, aunt of the latter case (57) acted as nurse for the preceding case (56), and during the time that she was so engaged she visited in the home of this patient at least once after the visit of the mother, above mentioned. This would seem to account for the infection of the second case.

Case 58 and case 59, brother and sister, in Stockbridge, were taken ill on the same day, October 10.

Two days previously the sister went with her parents to Albany and return, by automobile. On October 9 there was some malaise, and on the 10th she was taken ill, almost at the same hour as her younger brother.

She speedily recovered after five days in bed, and may possibly be regarded as an abortive case.

Aside from possible contact with a case in Stockbridge of two or three years' standing, there was no known contact, direct or indirect, with other cases.

Case 49.

I. V., nine years, South Lee. Dr. Markham, Lee. Ill October 3, with fever and pain in the back. Later there was pain in the neck, arms and legs. On the third and fourth day there was vomiting. Bowels constipated. On October 8 the paralysis appeared in the right leg, then in the left leg; and on the following day in the left arm, then in the right arm. Later in the day the patient died, with paralysis of respiration, the throat muscles being involved also.

There are 3 other children in the family. After the first three or four days they were kept apart from the patient. The children attended school in South Lee. This was the only case in South Lee.

Case 50.

J. B., eight years, 34 Prospect Street, Lee. Dr. J. J. Hassett, Lee. On November 4 had fever, headache and vomiting, also some diarrhœa. On November 6 occurred paralysis of the right arm and forearm. Pain and tenderness in the arm became very severe on November 8.

Patient attended the parochial school. Five other children in the family. This was the second of the 2 cases in Lee, and was in no way connected with the former. No known contact, direct or indirect, in either of the cases.

Case 51.

P. J., five years, Fairview, Lenox. Dr. Hale, Lenox. This is apparently an isolated case, occurring in the central portion of the town early in April. There may have been some exposure to cold a few nights before while watching a large fire. About April 12, fever began. About April 26, when paralysis of both legs occurred, the flesh was sore to the touch, the bones ached, the boy was listless and wanted to be held. Diarrhœa was present early.

A sister, eleven years, in the family. No known contact with other cases.

Case 52.

W. K., three years, Depot Street, Lenox. Dr. F. A. Roberts, Pittsfield. This, the second case in Lenox, also appears to be an isolated case. On May 29 mother thought the child was about to have a convulsion. On following day mouth and throat were sore. On June 2, the glands in the neck were swollen and so continued for two days. The first symptom of paralysis noted was on June 23, when the child began talking through the nose. Dr. Hale was called and thought of adenoids. On June 25 or 26, paralysis appeared in both arms and both legs. He was also unable to hold his head up.

Three other children in the family. No school at this season.

Case 53.

E. M., twelve years, Cliffwood Street, Lenox. Dr. A. C. England, Pittsfield. On September 22, had fever and some pain and tenderness in the right leg, which became paralyzed on the evening of the same day.

Patient attended the Center School, and played with case 51 (April) in June, and just recently walked to school with a sister of the preceding case (52, June 29). No other contact known.

Case 54.

E. H., Dr. J. J. Hassett, Lee. This case omitted from the summary, because it is now said to be a case of hip disease (Feb. 10, 1910).

Case 55.

E. P., two years, New Lenox. Dr. I. S. F. Dodd, Pittsfield. An isolated case in the country, near an electric car line. In August the child was one day in Pittsfield with its mother. October 1, some pain in the head, face, and on October 2, paralysis of both legs, slight in the left. Constipated.

Two other children in the family; 1 in school.

Case 56.

J. T. C., eighteen months, Valley Mill, near Lenox station. Dr. J. J. Hassett, Lee. An isolated case near the electric and steam railways. Fever appeared on October 17. On following day was paralyzed in both legs. There was constipation, and some pain in the left leg, which was the worse.

An only child. No other case near except the following (case 57).

Case 57.

G. L., two years, Lenoxdale. Dr. J. J. Hassett, Lee. Fever up to 102.5° on November 16. On following day pain in the back and paralysis in both legs. Constipation. Mild case.

An only child. On line of electric and steam cars. The child's mother visited the preceding case (56) at Lenox station, held and kissed the baby, who was then ill, about a month before her own baby developed the disease. This baby's aunt, who assisted in caring for the C. baby (case 56), was also here at least once during her stay at the child's home. This is the only known contact with other cases.

Case 58.

L. B., two and a half years, Stockbridge. Dr. J. R. Hobbie, North Adams. Taken ill on October 10, with fever and considerable pain, apparently due to retention of urine, which continued for forty-eight hours. There was some retraction of the head. Constipation. On October 12 there was paralysis of the right leg.

A brother of case 59.

Case 59.

A girl, B., eight years, Stockbridge. Dr. J. R. Hobbie, North Adams. On October 8 went with her parents in an automobile to Albany to see the Hudson-Fulton celebration. They returned the same day. On the following day she did not feel well. On the 10th of October, almost at the same hour as her brother, she had fever, and felt as if she could not move. Her head was retracted somewhat.. She was in bed for five days, for two days was unable to move her legs. She recovered speedily.

There is in the same town a case of two or three years' standing, with which there may have been some contact.

SUMMARY, GREAT BARRINGTON AND VICINITY.

In this group were 23 cases.

The first cases occurred in the country, near each other, on August 11 (case 80) and August 20 (case 81) in Sheffield and Egremont, respectively.

The 19 cases in Great Barrington occurred during September and the first week in October.

Two cases in Austerlitz, N. Y., included in this group, occurred on September 28.

In 18 cases there was paralysis.

Of the 5 cases which did not have paralysis, 3 were abortive (62, 69, 79), and 2 had paresis of both legs (70, 71).

Nearly all of the cases in Great Barrington (16 out of 19) are located immediately upon or quite near the Housatonic River, 4 being on the west and 15 on the east side of the river.

The 4 cases on the west side of the river, 64, 68, 69 and 71, on September 19, 22, 24 and 25, respectively, are well scattered.

These cases seem to have had no association with each other in any known manner, unless the possible indirect contact between case 68 (September 22), who was a first-year student in the high school, and case 69 (September 24), whose brother was in the eighth grade in the same building, be considered. Case 64 (September 19) was an only child, who had not been in school during the current school year.

This last case, and case 71 (September 25), had possible contact with cases on the opposite side of the river, as will appear later.

On the east side of the river were 15 cases, 10 of which were located on East Street and Avery Lane, practically a continuation of East Street. The 5 remaining cases were on cross streets near East Street.

From three households where were cases (61, 70, 72); no members attended school.

Cases 61 (September 8) and 72 (September 25) lived in adjoining houses some 200 feet apart, at the south end of East Street. There was more or less indirect contact between these 2 cases, because the second case visited the neighbor's child after it was ill, but she did not go into the house, though her sister did go into the house and assisted at times in caring for the first patient.

The source of infection for case 61 is not evident, though for one or two unlikely possibilities reference is made to the special notes on the case.

Case 70 (September 14) was an only child of three and one-half years, daughter of the man for whom case 72 worked as bookkeeper. It was

said that the latter had visited and held this child after it was ill, but this statement could not be verified. This child played much with a neighbor's children, one of whom attended the Bryant School, grade 2. There were no cases in this school.

Case 67 (September 22) was employed in a cotton mill, where were no other cases. A sister attended the eighth grade at the high school building, where the brother of case 69 also attended, with case 68 in the first year of the high school. There is no history, however, of any acquaintance or association other than the most casual between the one patient and the members of the other two households.

The group of cases (5) in Avery Lane, at the northerly part of the district, might readily be considered as contact cases, from association with each other, due to proximity, but further study of the matter makes it probable that they belong to a larger group, associated somewhat loosely with the Justin Dewey School.

To this group belong the 11 remaining cases on the east side of the river and cases 64 and 71 on the west side of the river. The details are as follows: —

The schools opened on September 7, and sessions continued through Friday, September 24, when a recess was taken for a week, on account of the Great Barrington fair. School work was resumed on Monday, October 4.

Whenever school is mentioned below, it refers to the Justin Dewey School.

Case 60 (September 3) did not attend school, but a brother regularly attended the fifth grade, while a brother and sister attended the fourth grade regularly.

Case 62, an abortive case, taken ill on September 16, attended school, grade 2, on September 7 and 8. She was then out till October 18. A sister attended the eighth grade regularly.

Case 63, a brother of the foregoing, became ill on September 23. These two children slept in the same bed with the mother, and the brother, who was four years of age, probably received his infection from the sister.

Case 63A (September 16) did not attend school, but two sisters did, one in the third grade and one in the second grade, and they were regularly present from the opening of the session on September 7. There was also contact with case 60, because the families lived in closely adjoining houses, and the children played together considerably.

The teacher in grade 3 is an aunt of case 64, September 19, and is accustomed to seeing her niece (case 64) frequently.

Case 65 (September 20) attended grade 3 till September 22.

Case 66 (September 20), an infant, had a brother who attended grade 3 regularly.

Case 71 (September 25) attended grade 2 till September 24.

A boy in the family of case 73 (September 25) regularly attended grade 6.

Case 74 (September 25) attended grade 4 regularly till September 24. He returned to school October 19. A brother of this patient attended grade 2 regularly.

Case 75 (October 2) had a brother, case 76 (October 6), who was in school October 4 and 5 after the recess for the fair. Another child, of whom there are 12 in this family, attended the sixth grade regularly.

A sister of case 77 (October 7) attended grade 6 regularly.

Thus between September 16 and October 7, 13 cases are associated directly or indirectly with the Justin Dewey School.

The diagram illustrates the distribution of the cases.

The 23 cases were cared for by four physicians. One physician had 10 cases, one 8, one 3 and one 2 cases.

Three of the physicians have families and children. There were no cases in physicians' families.

The physician who had 10 cases, after being called to his first patient, visited two families where infantile paralysis occurred subsequently. These calls were on chronic cases of other illness, and he did not come in close contact, if, indeed, he even saw those who had anterior poliomyelitis later. Further, in each of these two instances there were other possibilities of direct contact with other cases of the disease.

Another physician, who between September 19 and 29 saw 8 cases, had not been in any of the homes in question for a considerable period until called for the present illness.

Only 3 of the cases are on the line of the electric railway or the route taken by automobiles in passing through the town, though 5 other cases are quite near.

Only 1 case is close to the line of the railroad.

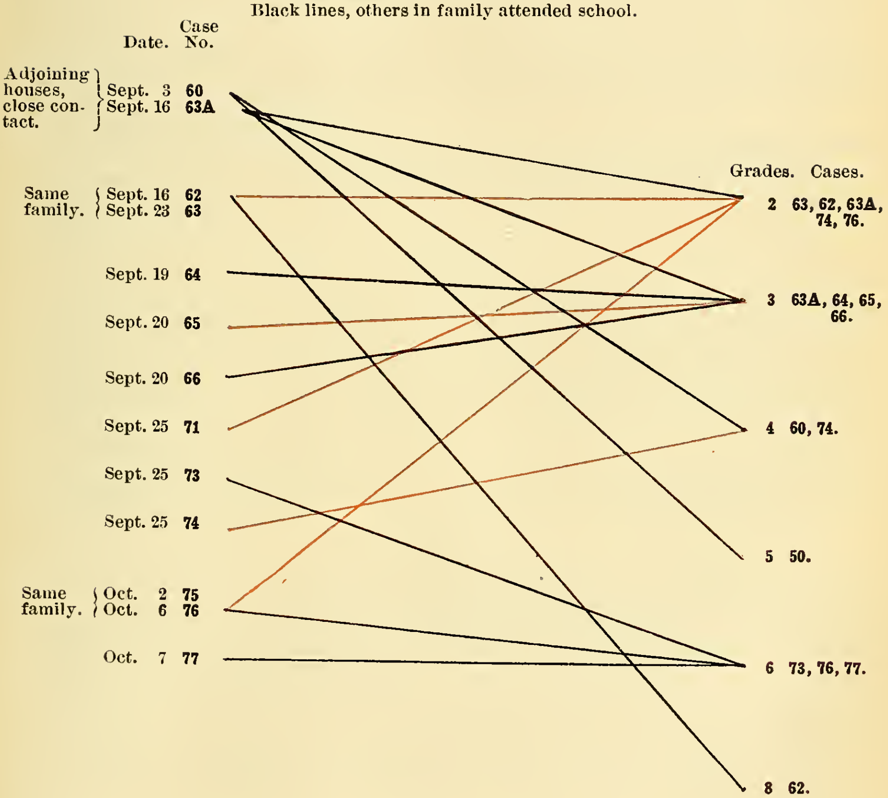
Case 60.

E. C., six years, East Street, corner Cottage Street, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. On September 2 was observed to limp slightly when walking. On the following day had fever (100° to 102°), vomiting, and pain in leg and knee. On September 6 there was paralysis of the left leg.

There are 5 other children in the family. This child attends the Dewey School, grade 2, though he did not enter this year until October 18. Two or three of the other children attend the same school, up to the fifth or sixth grade. J. in the fifth. Father is a lineman for the Great Barrington Electric Light Company.

DEWEY SCHOOL CASES, 1909.

Red lines, patient attended school.
Black lines, others in family attended school.



Case 61.

M. F., two years, 215 East Street, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. Fever (102°) began on September 8, accompanied by some delirium; would not stay in bed; once fell to floor. A week later, on September 15, there was paralysis of both legs, left arm and left face. There was some retention of urine for nearly twenty-four hours. No evidence of paralysis now present (November 3). One other child, of four years of age, occupied the same bed with the patient throughout the whole illness, and still continues to do so.

The F. case (72, September 25) lives a short distance away in the adjoining house.

The Sheffield case (80, August 11) is a cousin of this boy's mother, but there had been no communication between the families for a long period prior to this child's illness.

A cousin's child on the father's side had an attack of this same disease in Sharon, Conn., early in the spring. Between these families there is a regular exchange of letters, with which this baby may have played.

Case 62.

E. O., seven years, 72 State Road, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. Taken ill on September 16, with fever, headache, pain in back of neck, lower part of back and leg ache. Slight sore throat. Pain in legs and ankles continued for two or three days. Well since.

Attended Dewey School, grade 2. Entered on September 7. Beginning September 9 was out continuously to October 4, when she returned to school.

Sister of case 63.

Case 63.

J. O., four years, 72 State Road, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. Taken ill with fever (104°), vomiting and pain between the shoulders on September 23. Constipated. On September 26 or 27, paralysis of both legs.

This child and sister, above mentioned, slept in the same bed with the mother.

There are 2 older girls in the family who are not in school.

Case 63A.

D. G., four years, 6 Cottage Street Extension, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. For two or three weeks before onset of illness, on September 16, complained of feeling tired, especially in the legs, on walking. On or about September 16 had high fever, was dull and quiet, and wished to be let alone. There was pain under the left knee. About September 26 there was paralysis of the extensor muscles of the left

leg; patient could not straighten out the left leg. Later she was unable to stand on that leg for several weeks. Now (April 5, 1910) quite well, except that she has less endurance than before.

Case 64.

H. M., six years, 34 Castle Hill, Great Barrington. Dr. Bebee, Main Street, Great Barrington. One week before illness was operated on for adenoids and tonsils at home, by Dr. Blanchard of Pittsfield. Two days before had a slight fall, no ill effects so far as known. Taken ill with fever and vomiting; was dull and sleepy on September 19, and on the following day there was paralysis of the left leg, of mild degree.

No other children in the family; not in school this year.

An aunt, teacher in Justin Dewey School, grade 3, is a frequent visitor.

Compare with case 78, last paragraph.

Case 65.

G. J. F., seven years, 41 Russell Street, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. No previous illness, except that two weeks before did considerable running and racing at school. On September 20, headache, also fever, which continued to September 26. From the 21st to the 24th he was delirious. On September 22, vomiting and paralysis of both legs. Diarrhœa was present one day. Apparently recovered by October 11.

No other children. Attended Dewey School, grade 3. Was out of school from September 22 to October 17, inclusive.

Case 66.

M. E. W., fourteen months, 63 East Street, Great Barrington. Dr. Bebee, Main Street, Great Barrington. Became ill with fever on September 20. Vomiting followed dose of castor oil. September 24 discovered that there was paralysis of both legs, the right more severely.

An only child. No known contact with other cases.

Case 67.

H. D., sixteen years, 49 Cottage Street, Great Barrington. Dr. Bebee, Main Street, Great Barrington. On September 22, medium headache, loss of appetite, malaise and slight fever. Considerable pain in lumbar region and in legs. On September 25, 26 and 27, vomiting. On September 26, paralysis of right leg, and paralysis of left leg on September 28.

Two other children in the family; none in school. This girl worked in the finishing room at the Edgemere Manufacturing Company (spreads).

Case 68.

D. B. R., fourteen years, 12 Barrington Place, Great Barrington. Dr. C. H. Chapin, Main Street, Great Barrington. On September 22, vomiting,

which continued all of the following day, when fever appeared (102° to 103°). On the evening of September 24 appeared paralysis of both sides of the face. On the 25th there was delirium, later dullness, gradually increasing till patient became comatose, death taking place on September 27. On September 25 there was paralysis of the labio-glosso-pharyngeal muscles, so that the jaw dropped and he could not put it forward. During the last twenty-four hours there was incontinence of urine and feces.

He was a first-year student in the high school, at Searles Building. Other children in family; none in school.

Case 69.

J. R., five years, 31 Dresser Avenue, Great Barrington. Dr. Bebee, Main Street, Great Barrington. On September 24, considerable fever. On 25th, headache, and on 26th gradually became completely unconscious, which condition lasted till the following day, nearly twenty-four hours in all. Rapid recovery followed.

A brother attends the eighth grade at high school, Searles Building. Two other boys in the family.

Compare cases 78 and 79.

Case 70.

A. H., three and a half years, 135 East Street, Great Barrington. Dr. Bebee, Main Street, Great Barrington. This child, with its mother, was in Pittsfield on July 4. About September 14, without initial fever, there was noticeable lameness of the left leg, followed by a similar lameness in the right leg. On September 18 there was tenderness about the neck and arms, later in the legs. On September 20 vomiting began, which continued through the following day.

An only child. Played intimately with children on opposite side of the house, kissing the baby frequently. Case 72 (Sept. 25) was employed as bookkeeper by this child's father. No source of infection known.

Case 71.

G. B., seven years, 87 Railroad Avenue, Great Barrington. Dr. Bebee, Main Street, Great Barrington. Some fever and vomiting on September 25. Better the following day and went to church. On the 28th he went to the cattle show. On September 29, again had slight fever, headache and stomach ache. On September 30, paresis of right leg.

Only child in family. Attended Dewey School, grade 2, till September 24, then out till October 26. At Dewey School in possible contact with cases 60 and 76.

Case 72.

K. F., twenty-five years, 225 East Street, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. On evening of September 25, vomiting. On 26th and 27th very nervous. On 28th seen by physician. She had little or no fever. She was not seen on the 29th. On the 30th he found her sitting up, but in appearance severely ill, with an acute in-

fection; the mouth was dry, there was sordes on the teeth. No fever. She could move the right leg with great difficulty only. Later, the right arm and the right leg were paralyzed. On October 1, delirium appeared and continued for three days. On October 4 was unable to articulate distinctly, but the condition improved on the 5th and 6th. At that time (October 6) there was slight difficulty in swallowing, and on the night of the 6th of October patient died, with evidences of respiratory paralysis.

Was said to have seen her employer's child (case 70, September 14) a few days before her own illness. This however, is said not to be so by the latter's family. She went also to the house of case 61, living in the next house, some distance away, but did not go in. Her sisters, however, did go in, and one of them helped care for the child and kissed him. The patient, however, had a room to herself.

Case 73.

H. C., fourteen months, 32 Avery Lane, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. A mild case, taken ill on September 25 or 26, with drowsiness and fever, pain in the legs. Previous to this time the baby crept and would take a few steps. With the onset as above described was unable to do either. On October 10, began again to creep slightly.

Other children in family. One boy is in Dewey School, grade 6. Cases 74 to 77, inclusive, in the immediate neighborhood.

Case 74.

H. H., ten and one-half years, 16 Avery Lane, Great Barrington. Dr. C. S. Chapin, Main Street, Great Barrington. Early in September had a slight headache and some fever for two days. On September 28, fever, with some delirium for the first night, headache, nausea and some soreness in lower part of back and right leg. On October 5, paralysis of right leg. Slight disturbance of left leg for one day.

Attends the Dewey School, grade 4. Was out from September 24 to October 19, inclusive. A brother attends same school, grade 2, and had no absences. Cases 73 and 75 to 77, inclusive, in the immediate neighborhood.

Case 75.

E. C., twenty months, 29 Avery Lane, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. On October 2 walked poorly. On October 4, fever, pain in lower back and right leg and vomiting. On October 5, paralysis of right leg. Brother of the following case.

Case 76.

J. C., seven years, 29 Avery Lane, Great Barrington. Dr. M. T. Cavanaugh, Main Street, Great Barrington. On October 6, severe headache, vomiting and delirium at night. Fever, 103°. Some pain about the face and in the legs. On October 8, paralysis of right side of face.

Brother of the foregoing case.

Attended school at Dewey School, grade 2. Another brother attended same school, grade 6. This brother was regularly in school. The patient attended from the beginning of the term till the vacation for the fair, on September 24, with the exception of September 22. He was in school October 4 and 5, leaving on October 6. There are 11 other children in the family, 12 in all. In close contact with other Avery Lane cases.

Case 77.

M. O., two and a half years, 26 Avery Lane, Great Barrington. Dr. C. S. Chapin, Main Street, Great Barrington. Fever, some headache, delirium, beginning on October 7. Moderate retraction of head, and pain in right leg. Vomiting. On October 11, paralysis of right leg.

Sister attends Dewey School, grade 6. In contact with cases 73 to 76, inclusive, in same vicinity.

Case 78.

J. M., seven years, Austerlitz, N. Y. Dr. Bebee, Main Street, Great Barrington. This case and following are here included because they were seen by Dr. Bebee, and because of the resemblance of this case, in some particulars, to case 69. On September 28 returned from school, feeling miserable. On 29th was drowsy, and on the 30th still more so, becoming unconscious on the following day; and on this same day he became paralyzed in both arms and both legs. The unconsciousness continued almost without interruption till October 5.

He is a nephew of the domestic employed at the home of case 64 (Sept. 19) in Great Barrington, but there was no visiting between the two places for a considerable time prior to the time case 64 became ill. Letters were received from the domestic telling of the case in her employer's family. Neither did the aunt visit Austerlitz till considerably later.

There was a second case, an abortive one, in the family, as follows: —

Case 79.

D. M., five years, Austerlitz, N. Y. Dr. Bebee, Main Street, Great Barrington. Brother of the foregoing. September 29, 30, and October 1, acted queerly, complained of being dizzy and unable to walk. Three days later was quite well again, and had no further trouble.

In the western part of the town, without any known connection between them, through schools or otherwise, there were said to be 3 other cases, 2 of them in one family. This is a country town, with hardly a village or hamlet, the houses being considerably scattered.

Case 80.

G. D., twenty years, Sheffield, near Egremont line. Dr. A. T. Wakefield, Sheffield. About August 11, taken ill with fever, 100.5° to 102°, headache. Moderate retraction of head, pain and tenderness over lower dorsal and lumbar regions. On August 14, paralysis of both legs, and paresis of right arm.

No known contact with other cases. May have been in Great Barrington for a day previous to being ill, but at that time no cases in the town (Great Barrington). Lives on a farm, well isolated from any other case. Previous to his illness was an intimate associate with the following case.

Case 81.

F. L., twenty-one years, Egremont, near Sheffield line. Dr. A. T. Wakefield, Sheffield. Was an intimate friend of the preceding case (80), though the date of the last contact between the two cannot now be established. On August 20, sudden headache, repeated vomiting, and fever, never over 101°. There was retraction of head, and considerable pain in back and legs. On August 21, paralysis of both legs, together with some disturbance of the arms and back. Retention of urine after first twenty-four hours. The paralysis increased, and on the morning of August 23 he died from paralysis of respiration.

Acknowledgment is hereby made of the uniform courtesy and co-operation on the part of all the physicians whose cases were the subject of investigation.

ORIGIN AND PREVALENCE OF TYPHOID FEVER IN BOSTON IN THE YEAR 1909.[1]

Introduction.

The work upon which the following report concerning typhoid fever in Boston during the year 1909 is based was begun August 15, and continued until the close of the year. The thanks of the investigator are due to Dr. Mark W. Richardson, secretary of the State Board of Health, and to Dr. M. J. Rosenau, Professor of Preventive Medicine at the Harvard Medical School, for their advice and assistance; and to the officials of the boards of health of Boston and adjacent cities for their courtesy in furnishing information concerning the reported cases. Financial assistance in carrying on the work was obtained from the State Board of Health and from the Charles Follen Folsom Fellowship in Hygiene of the Harvard Medical School.

At first the object of the investigator was to study the cases in as complete detail as possible, but the carrying out of this intention soon proved to be impossible, owing, first, to the magnitude of the problems that were uncovered in the process of the investigation; secondly, to the attempt of the investigator to study, simultaneously with the Boston cases, various outbreaks of typhoid fever in other parts of the State; and thirdly, to the

[1] By Donald Gregg, M.D., Agent of the State Board of Health, Charles Follen Folsom Fellow in Hygiene, Harvard Medical School.

investigator's inability, owing to his departure from Boston, to complete the study of several small local epidemics, of suspected "typhoid houses" and suspected "typhoid carriers."

This report is to be considered merely as a preliminary survey of the problem. Further study of the situation, in the opinion of the investigator, should be undertaken by a single individual, qualified to spend his whole time studying the origin and prevalence of typhoid fever throughout the State.

Method.

The office of the Boston board of health was first visited. Here was obtained the name, address and age of the individual reported as being sick with typhoid fever. Here, also, was learned the name of the doctor making the report and the date of the notice. This information was recorded upon a typhoid fever case card, devised as follows: —

Name,		Age,	Res.,			Ward,
Birthplace,		Duration of Residence,			Occupation,	
	Reported by			Date,		
F.H.	F.	M.	B.	B.*	S.	S.*
	Children,			Neighbors,		
P.H.						
Water,	Milk,		Veg.,		Fish,	
Gen. Hyg.,				Sewerage,		
P.I.	Date of Onset,			Duration,		
	Complications,			Result,		
			P. S. I.			
Present Res.						
Present Occup.						

An explanation of some of the abbreviations may be advisable.

Under "F. H." (family history) are spaces for recording information concerning members of the patient's family, the father ("F."), mother, brothers and sisters, the brothers and sisters dead ("B.*", "S.*"), children and neighbors. The information here recorded concerned largely the present or past existence of typhoid cases and their relationship to the patient, as possible evidence of the source of the infection of the case in hand. Under "P. H." (past history) were recorded the recent activities of the individual, — date of his return to the city, etc. The sources of articles of food ingested were next noted. Under "Gen. Hyg." were noted briefly the conditions favoring contact infection — filthy tenements, flies, etc. Most of the other items are self-explanatory. Under "P. S. I." was noted briefly the probable source of infection, —

whether from milk, water, shellfish, contact; whether of local or imported origin, etc.

Another and a better card is the following one, used by the investigators of the typhoid fever situation in Washington, D. C. This card is better adapted for permanent records.

TYPHOID FEVER CASE CARD.

Date of investigation, Case No.
Name,
Age, Color, Sex, Nationality,
Probable date of onset, Date definite symptoms,
Name and address of physician,

Residence.

How long resident in District of Columbia,
Residence when taken sick, ; from to
Previous residences, ; from to
Subsequent residences, ; from to
Temporary absences from District of Columbia within thirty days prior,
Number of occupants, ; ages,
Number of occupants who have had typhoid, ; when, .
Newcomers in house within three months prior,
Newcomers in house had typhoid?
Servants:
White: Resident, Typhoid?
Nonresident, Typhoid?
Colored: Resident, Typhoid?
Nonresident, Typhoid?
Typhoid at homes of servants? When?
Disposal of sewage, Water-closet in house?
Water-closet in yard? Privy? Location?
General sanitary condition of residence,

Occupation.

Place, ; from to
Other cases,

Water.

Within thirty days prior, Solely, Principally,
Occasionally,

Food.

Within thirty days prior,
Where taken,
Milk (how used), ; from Boiled? Pasteurized?
Ice cream? Where?
Uncooked fruits and vegetables,
Shellfish,

Contact.

Association thirty days prior with patients in febrile stage,
Association with suspected cases,
Association with persons who have had typhoid within six months, one year, ; two years, ; three years, ; four years, ; five years,
Association thirty days prior with persons in contact with patients in febrile stage,
Treatment of stools and urine of patients,
Other precautions,
Remarks:
Summary:

Signature:

Having obtained the preliminary information of the name, address, etc., from the Board of health office, the investigator then looked up the case, and obtained, when possible, the additional information desired. This information was obtained most often from the individual himself, or from members of the family or friends. In some cases the attending physician kindly furnished the information. Especial thanks are due to the officials of hospitals, where many of the cases were treated, for their courtesy in giving information concerning the patients, and in permitting them to be visited.

In many cases, owing to the lapse of time between the report of the case and its investigation, or to other reasons, only a partial report could be obtained. The following tables and percentages are, therefore, at times based on incomplete data. There is no reason for believing, however, that complete returns would modify the conclusions drawn.

The report of the cases by months is shown in the following table. Any discrepancy between these tables and those of the Boston board of health is due to the fact that certain cases were reported by both the attending physician and the hospital to which the case was later sent, and are thus sometimes counted twice in the Boston lists. Together with the reported cases are noted unlisted cases, *i.e.*, cases not upon the Boston lists, which were either not recorded or noted merely as questionable cases and not verified.

Reported and Unlisted Cases.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Reported, . .	51	11	24	22	26	33	33	70	142	134	70	42	658
Not listed, . .	7	–	3	–	3	5	6	7	4	2	–	3	40
Totals, . .	58	11	27	22	29	38	39	77	146	136	70	45	698

DIAGNOSIS.

In most cases the diagnosis as made by the attending physician was accepted as final. No attempt was made, without the physician's consent and assistance, to verify the diagnosis by blood cultures or Widal reactions. The investigator was ready to assist the attending physician with these tests, but in the majority of cases such tests would have been made too late to have been of any clinical value. Many cases were reported as typhoid fever without a Widal or blood culture test having been made, and quite a number of these cases were probably wrongly diagnosed. Oftentimes cases reported as typhoid fever were sent to the hospitals and there otherwise diagnosed. These cases are classed as "false hospital cases" in the accompanying table. Cases not sent to the hospital, where the subsequent clinical history showed clearly a condition other than typhoid fever, are grouped as "false home cases."

False Cases.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Home, . . .	2	–	1	4	2	4	–	4	3	4	4	5	33
Hospital, . .	10	4	10	7	5	8	11	10	10	11	10	10	106
Totals, . .	12	4	11	11	7	12	11	14	13	15	14	15	139

Of the false cases, 106, or 76 per cent., were hospital cases, 33, or 24 per cent., home cases. The distribution of the false home and hospital cases by months and wards is shown in the following tables: —

False Home Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
January, .	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
February, .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	-	–
March, . .	-	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
April, . .	–	–	–	–	–	2	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	4
May, . .	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	2
June, . .	1	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
July, . .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
August, . .	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	4
September, .	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	3
October, . .	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	1	–	4
November, .	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	4
December, .	–	–	–	1	–	1	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	5
Totals, .	1	2	1	1	1	10	1	4	–	–	–	–	1	1	–	–	2	–	1	1	–	4	–	1	1	–	33

False Hospital Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
January, .	–	1	–	–	-	–	–	–	2	2	–	1	–	1	1	–	1	1	–	–	–	–	–	–	–	–	10
February, .	–	–	–	–	–	1	–	–	1	-	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	4
March, . .	–	1	1	1	–	–	–	–	–	1	–	1	–	–	–	–	1	1	–	–	1	–	–	2	–	–	10
April, . .	–	–	–	–	1	1	–	–	2	–	–	-	–	1	–	–	–	–	–	–	–	2	–	–	–	–	7
May, . .	–	–	–	–	–	1	–	-	–	1	–	–	–	–	1	–	–	–	-	–	1	–	1	–	–	–	5
June, . .		–	–	1	-	3	–	–	1	–	–	–	–	1	-	–	2	–	–	–	–	–	–	–	–	–	8
July, . .	–	–	–	–	1	–	1	–	–	–	–	1	1	1	1	2	–	-	–	1	–	1	–	–	1	–	11
August, . .	1	1	–	–	1	–	2	–	–	–	–	–	–	–	–	1	1	1	–	1	–	–	–	1	–	–	10
September, .	–	–	1	–	3	1	–	–	–	–	–	1	–	1	–	1	–	–	–	1	–	–	–	–	1	–	10
October, . .	1	1	2	–	–	–	–	1	3	2	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	11
November, .	–	1	1	–	–	–	–	–	–	–	–	1	–	–	–	2	–	–	–	–	2	–	–	2	1	–	10
December, .	–	–	–	–	–	2	–	2	–	1	–	–	–	1	–	1	1	–	–	1	–	1	–	–	–	–	10
Totals, .	2	5	5	2	6	9	3	3	9	7	–	5	1	6	3	7	6	3	1	5	4	5	1	5	3	–	106

Of 698 reported or unlisted cases, 416 received hospital treatment. Out of these 416, 106, or 25 per cent., were not typhoid fever. Two

hundred and eighty-two cases were treated at home; 33, or 12 per cent., of these cases were considered not to be typhoid fever. More careful investigation of the home cases would probably have shown a larger percentage of false home cases.

The distribution of the cases by wards reflects slightly the local conditions.

The list of diseases considered and reported to be typhoid fever is as follows: febricula, 24; pneumonia, 19; malaria, 10; tuberculosis, 9; no diagnosis, 9; influenza, 8; bronchitis, 7; appendicitis, 4; enteritis, 4; meningitis, 4; pleurisy, 3; pyelitis, 3; anterior poliomyelitis, 3; endocarditis, 3; cirrhosis of liver, 2; empyema, 2; mastitis, 2; and 1 case each of kidney abscess, secondary anæmia, exophthalmic goiter, syphilis, gastritis, tumor of kidney, liver abscess, scarlet fever, pneumo-thorax, orchitis, mitral disease, salpingitis, peritonitis, erythema multiforme, fractured skull, infectious arthritis, malignant endocarditis, lumbago, otitis media, laryngitis, Cowperitis, alcoholism, phlebitis, myositis and perinephritis.

The waste of health, time and life resulting from the treatment of malaria, appendicitis, tuberculosis and poliomyelitis as typhoid fever hardly needs comment.

In the following tables are shown the "true cases," distributed by months and wards. The list was obtained by subtracting the false cases from the reported ones, and adding thereto the unlisted cases.

True Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
January,	–	1	2	–	–	3	1	5	4	2	–	3	3	4	2	3	2	4	–	3	–	–	2	–	1	1	46
February,	1	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	1	7
March,	1	4	1	–	–	2	–	–	–	–	–	–	–	–	2	–	–	1	–	–	1	4	–	–	–	–	16
April,	–	1	–	–	1	1	–	–	–	–	–	–	1	–	1	–	1	–	–	–	–	3	1	–	–	1	11
May,	1	3	–	3	–	2	1	–	1	1	–	2	–	2	1	–	–	–	–	1	–	1	–	2	–	1	22
June,	–	5	–	–	–	6	1	–	1	–	1	–	1	2	–	–	1	2	–	1	–	1	–	1	2	1	26
July,	–	1	–	–	1	–	1	3	4	–	–	–	2	2	2	1	–	–	2	2	1	2	–	–	1	3	28
August,	2	5	4	–	10	3	1	2	1	–	3	2	–	3	1	3	1	–	3	5	3	2	1	6	2	–	63
September,	4	4	1	4	9	1	3	3	–	2	1	1	7	4	1	1	3	1	4	8	3	–	3	2	61	2	133
October,	4	10	7	8	3	1	1	3	–	1	5	4	1	3	3	6	2	1	7	16	5	5	2	7	11	5	121
November,	1	2	2	5	3	2	2	–	–	2	–	3	3	3	2	–	2	3	4	4	1	4	1	3	2	2	56
December,	–	6	–	–	–	3	–	1	–	–	1	2	1	4	–	–	–	1	1	3	3	–	–	1	1	2	30
Totals,	14	42	20	20	27	24	11	17	11	8	11	17	19	27	15	14	12	13	21	43	18	22	10	23	81	19	559

Conclusions.

First, the present method of listing cases chronologically permits them to be entered twice on the list. Secondly, cases reported "questionable" and not verified are usually listed among the typhoid cases only in case of subsequent death, and in this way the typhoid morbidity is not accurately gauged by the list as posted. Thirdly, the nonverification of reported typhoid cases results in a considerable error in the compilation of health statistics, both as regards morbidity and mortality. Fourthly, the nonverification of reported typhoid cases favors a certain amount of malpractice. Much of this is corrected by the hospitals, or by the transference of cases from one physician to another. Fifthly, the suffering and death caused by the treatment of appendicitis, poliomyelitis, tuberculosis, pneumonia, etc., as typhoid fever demand a more careful supervision on the part of the public health officials. Sixthly, no satisfactory solution or handling of the typhoid fever problem can be accomplished until the individual typhoid cases are speedily and correctly diagnosed.

Study of the True Cases.

The date of the morbidity was found to be difficult to determine accurately in many cases, owing to the insidious onset of the disease. The date when the patient first definitely realized he was sick was usually recorded. This sometimes coincided with the onset of chills, fever, going to bed or calling the doctor.

The morbidity, distributed according to months and wards, is shown by the accompanying charts and tables: —

Morbidity of Cases. — Local Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
Before January,	–	–	1	–	–	1	–	5	2	1	–	–	2	3	2	1	1	2	–	2	–	–	1	–	–	–	24
January,	1	1	4	–	–	–	1	2	–	–	–	1	1	1	–	1	1	2	–	–	1	–	1	1	–	–	19
February,	1	–	1	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	5
March,	–	3	–	–	–	–	1	–	–	–	–	–	1	–	–	–	1	1	–	–	–	1	–	–	–	–	8
April,	1	2	–	2	1	–	1	–	1	–	–	1	–	1	1	–	–	–	–	–	–	3	1	–	–	1	16
May,	–	5	–	–	–	4	–	–	–	–	–	–	1	1	1	–	–	1	–	–	–	1	–	3	–	–	17
June,	–	2	–	–	–	3	–	–	3	–	–	–	–	2	–	–	1	1	1	–	–	1	–	–	1	–	15
July,	1	3	–	–	3	1	1	3	2	–	–	1	1	2	1	1	1	–	2	1	1	–	–	2	–	–	27
August,	1	1	4	1	7	2	1	–	1	–	2	1	2	3	1	1	–	–	3	5	1	2	1	3	32	–	75
September,	5	4	3	3	6	1	1	4	–	1	–	2	3	2	–	2	1	2	5	4	2	2	1	5	35	–	94
October,	2	3	6	8	5	1	–	2	–	3	2	4	–	3	2	2	2	1	4	5	1	4	1	–	1	–	62
November,	1	–	–	2	–	1	–	1	–	–	–	1	2	2	–	–	1	3	2	4	2	1	–	3	–	–	26
December,	–	6	–	–	–	1	–	–	–	–	–	1	–	2	-	–	–	–	–	–	2	–	–	–	–	–	12
Totals,	13	30	19	16	22	16	6	17	9	5	4	12	13	22	9	8	9	13	17	21	10	16	6	17	69	1	400

Hospital and Home Treatment.

The number of cases treated at home and in the hospitals is shown in the following tables. Fifty-five per cent. of the cases are hospital cases.

Home Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
January,	–	1	2	–	–	1	–	4	1	1	–	2	–	–	1	2	–	2	–	1	–	–	2	–	–	–	20
February,	1	-	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	5
March,	–	3	1	–	–	2	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	2	–	–	–	–	10
April,	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	2	1	–	–	–	5
May,	–	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	5
June,	–	1	–	–	–	6	–	–	–	–	1	–	–	–	–	–	1	1	–	1	–	1	–	1	1	–	14
July,	–	–	–	–	–	–	–	1	–	–	–	–	1	1	–	1	–	–	2	1	–	–	–	–	–	–	7
August,	–	1	–	–	–	1	–	–	1	–	2	–	–	–	–	1	–	–	1	3	3	2	1	2	1	–	19
September,	2	2	1	2	4	1	–	1	–	2	–	–	1	–	–	1	2	–	1	6	2	-	3	2	40	–	73
October,	3	3	1	2	1	–	–	2	–	–	3	–	1	1	2	3	2	1	4	12	4	1	1	5	8	–	60
November,	1	1	1	–	–	2	–	–	–	1	–	–	–	–	1	–	–	3	–	4	–	2	1	3	2	–	22
December,	–	–	–	–	–	2	–	–	–	–	1	–	–	2	–	–	–	–	–	2	2	–	–	–	–	–	9
Totals,	7	14	8	4	5	17	–	8	2	4	7	2	3	4	5	8	6	8	8	30	12	10	9	16	52	–	249

Hospital Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
January,	–	–	–	–	–	2	1	1	3	1	–	1	3	4	1	1	2	2	–	2	–	–	–	–	1	1	26
February,	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
March,	1	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	2	–	–	–	–	6
April,	–	1	–	–	1	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	1	–	–	–	1	6
May,	1	1	–	3	–	1	1	–	1	1	–	2	–	2	1	–	–	–	–	1	–	1	–	–	–	1	17
June,	–	4	–	–	–	–	1	–	1	–	–	–	1	2	–	–	–	1	–	–	–	–	–	–	1	1	12
July,	–	1	–	–	1	–	1	2	4	–	–	–	1	1	2	–	–	–	–	1	1	2	–	–	1	3	21
August,	2	4	4	–	10	2	1	2	–	–	1	2	–	3	1	2	1	–	2	2	–	–	–	4	1	–	44
September,	2	2	–	2	5	–	3	2	–	–	1	1	6	4	1	–	1	1	3	2	1	–	–	–	21	2	60
October,	1	7	6	6	2	1	1	1	–	1	2	4	–	2	1	3	–	–	3	4	1	4	1	2	3	5	61
November,	–	1	1	5	3	–	2	–	–	1	–	3	3	3	1	–	2	–	4	–	1	2	–	–	–	2	34
December,	–	6	–	–	–	1	–	1	–	–	–	2	1	2	–	–	–	1	1	1	1	–	–	1	1	2	21
Totals,	9	28	12	16	22	7	11	9	9	4	4	15	16	23	10	6	6	5	13	13	6	12	1	7	29	19	310

Conclusions.

The North End is the only poor district where a majority of the typhoid cases is treated at home. South Boston, East Boston and Charlestown send most of their cases to the hospitals. This may be partially explained by the Italian dread of hospitals and by the Irish knowledge of these valuable institutions. The advisability of sending all suspected cases to the hospitals is evident for the following reasons: first, the chance of secondary cases in the home is lessened; secondly, the patient receives treatment that is either better or less expensive, or both; thirdly, the diagnosis is more often correct, and consequently inappropriate treatment is less likely.

Race.

The grouping of cases according to race is based upon the birthplace of the patient, or, in the case of a child, the birthplace of the parents.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
American,	24	4	8	7	11	10	13	40	93	92	30	16	348
Belgian,	1	–	–	–	–	–	–	–	–	–	–	–	1
Canadian,	1	1	–	2	3	2	1	9	18	6	6	4	53
English,	–	–	–	–	–	–	2	–	–	1	2	–	5
Finnish,	–	–	–	–	–	–	–	–	–	1	–	–	1
French,	–	–	–	–	–	–	–	–	–	–	1	–	1
German,	–	–	–	–	–	1	–	–	1	1	1	–	4
Greek,	–	–	–	–	–	–	–	1	–	–	–	–	1
Hollander,	–	–	–	–	–	1	–	–	–	–	–	–	1
Italian,	6	–	6	1	3	6	5	2	4	6	5	8	52
Irish,	5	1	–	1	1	3	3	3	9	7	8	3	44
Negro,	–	–	–	–	1	1	–	1	1	1	1	–	6
Portuguese,	–	1	–	–	–	–	–	–	–	–	–	–	1
Russian,	2	–	–	–	3	–	2	6	–	–	–	–	13
Scotch,	–	–	–	–	–	–	–	2	1	1	–	–	4
Swedish,	2	–	–	–	–	1	2	–	2	2	1	–	10
Syrian,	2	–	–	–	–	–	–	–	–	–	–	–	2
West Indian,	–	–	–	–	–	–	–	–	–	1	–	–	1
Unknown,	–	–	–	–	–	–	–	–	–	–	–	–	11
Total,	–	–	–	–	–	–	–	–	–	–	–	–	559

Conclusions.

About 35 per cent. of the population of Boston is said to be foreign born, and about an equal percentage of the typhoid fever cases is distributed among these foreign peoples. About 1 per cent. of the fever cases is among the colored people, who form nearly 2 per cent. of the population. The number of cases among the Canadians, 53, or 25 per cent. of the foreign cases, includes many vacationists or emigrants who have come to Boston sick. The Italians, who are said to form about 10 per cent. of the foreign-born population, contribute more than 25 per cent. of the foreign cases. This number is augmented by a number of imported cases, — laborers who have been working outside of the city and have returned to Boston; it also includes, probably, a considerable number of cases not really typhoid fever.

Sex.

The sex of the cases is shown in the following table: —

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Males, . . .	28	4	6	7	14	14	15	46	62	66	34	21	317
Females, . .	18	3	10	4	8	12	13	17	71	55	22	9	242
Totals, . .	46	7	16	11	22	26	28	63	133	121	56	30	559

The predominance of males, 317, or 56 per cent., may be due to the greater activity of this sex as travelers. In September, during the milk epidemic in Brighton, when many households were infected, females predominated in number.

Age.

The age periods of the cases are shown in the following five-year division of the cases, compiled by months. The largest number of cases occurred between the ages of fifteen and twenty-five. This is the period stated by Osler to be the time of greatest susceptibility.

Ages.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Under 5, . .	4	–	1	1	–	5	–	2	8	7	3	4	35
6 to 10, . .	7	1	4	1	1	3	3	9	14	15	5	3	66
11 to 15, . .	4	1	–	2	5	3	4	9	13	13	4	3	61
16 to 20, . .	5	–	2	1	3	2	5	10	18	21	9	1	77
21 to 25, . .	6	–	1	1	4	5	5	15	20	19	8	7	101
26 to 30, . .	6	–	2	–	3	4	4	8	14	17	8	4	70
31 to 35, . .	7	2	1	1	3	–	3	5	15	8	7	1	53
36 to 40, . .	3	3	3	2	1	2	1	1	16	3	6	3	44
41 to 45, . .	4	–	–	1	1	–	2	1	5	4	1	2	21
46 to 50, . .	–	–	1	–	–	–	1	2	5	7	3	1	20
51 to 55, . .	–	–	1	1	–	–	–	1	3	4	1	–	11
56 to 60, . .	–	–	–	–	1	2	–	–	2	2	1	–	8
61 to 65, . .	–	–	–	–	–	–	–	–	–	1	–	1	2
Totals, . .	46	7	16	11	22	26	28	63	133	121	56	30	559

Occupations.

The occupations of the cases are grouped under two heads, — those that are exposed to infection, and those that are conducive to the spread of infection. Among the occupations especially to be noted for their number are those of traveling salesmen and railroad employees. Of the nurses, 2 were in attendance upon typhoid cases, 1 took care of an appendix case which proved to be typhoid fever, and 2 probably were infected while caring for gall bladder cases. No nurses were reported sick from the Massachusetts General Hospital, where prophylactic vaccination has been instituted. Some of the occupations, such as domestics, might be grouped under the second class also. The presence of 31 individuals involved in occupations conducive to the spread of typhoid fever probably explains many of the untraced sources of infection of other cases. Among the total number of cases 147 were school children, and 55 were women living at home, without other occupation.

Exposing Occupations.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Railway employee,	–	–	–	–	1	1	–	1	3	1	3	2	12
Traveling salesman,	3	–	–	–	2	–	–	3	1	–	1	1	11
Domestic,	–	–	1	–	–	1	1	–	4	–	3	1	11
Fisherman,	1	–	–	1	–	3	–	–	1	–	–	–	6
Physician,	1	–	–	–	–	–	1	1	1	1	–	–	5
Nurse,	–	–	–	–	–	–	–	1	–	2	–	2	5
Tailor,	2	–	–	–	–	–	–	1	1	–	–	–	4
Undertaker,	–	–	–	–	–	–	–	–	2	1	–	–	3
Scrubwoman,	1	–	–	–	–	–	–	2	–	–	–	–	3
Actor,	1	–	–	–	–	–	–	–	–	1	–	–	2
Longshoreman,	–	–	–	–	–	–	1	–	1	–	–	–	2
Shoe repairer,	–	–	–	–	–	–	1	1	–	–	–	–	2
Letter carrier,	–	–	–	–	–	–	–	–	–	1	1	–	2
Barber,	–	–	–	–	–	–	–	–	1	–	–	–	1
Disinfector,	–	–	–	–	–	–	–	–	–	1	–	–	1
Plumber,	–	–	–	–	–	–	–	–	–	1	–	–	1
Hospital scrubwoman,	–	–	–	–	–	–	–	–	–	–	1	–	1
Car conductor,	–	–	–	–	–	–	–	–	–	–	1	–	1
Totals,	9	–	1	1	3	5	4	10	15	9	10	6	73

Occupations conducive to the Spread of Typhoid Fever.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Restaurant helper,	1	–	–	–	–	–	–	–	–	–	–	–	1
Marketman,	1	–	–	–	–	–	–	–	–	–	–	–	1
Baker,	–	–	1	–	–	–	1	–	1	–	1	–	4
Sausage maker,	–	–	–	–	1	–	–	–	–	–	–	–	1
Waitress or waiter,	–	–	–	–	–	1	–	–	1	1	2	1	6
Grocery boy,	–	–	–	–	–	–	–	1	1	–	–	–	2
Laundryman,	–	–	–	–	–	–	–	–	3	–	–	–	3
Iceman,	–	–	–	–	–	–	–	–	1	–	–	–	1
Cook,	–	–	–	–	–	–	–	–	1	–	1	1	3
Cigar maker,	–	–	–	–	–	–	–	–	–	1	–	–	1
Grocer,	–	–	–	–	–	–	–	–	–	1	–	1	2
Masseur,	–	–	–	–	–	–	–	–	–	1	–	–	1
Liquor bottler,	–	–	–	–	–	–	–	1	–	–	–	–	1
Butler,	–	–	–	–	–	–	–	1	–	–	–	–	1
Milkman,	–	–	–	–	–	–	–	1	–	–	–	–	1
Vegetable peddler,	–	–	–	–	–	–	–	1	–	–	–	–	1
Water carrier,	–	–	–	–	–	–	–	–	–	–	–	1	1
Totals,	2	–	1	–	1	1	1	5	8	4	4	4	31

Mortality.

The mortality statistics are incomplete as some of the typhoid cases reported in December may increase the total number. In the following table is shown the mortality by months, and its distribution among the different nationalities: —

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
American, . .	3	–	–	1	1	3	4	2	11	13	2	1	41
Canadian, . .	–	–	1	–	–	–	–	2	11	3	–	–	17
English, . .	–	–	–	–	–	–	2	–	–	–	–	–	2
Irish, ...	1	1	–	–	–	–	2	–	3	1	3	2	13
Italian, . . .	–	–	1	1	1	–	1	–	–	1	2	1	8
Portuguese, . .	–	1	–	–	–	–	–	–	–	–	–	–	1
Swedish, . .	1	–	–	–	–	–	1	–	–	–	–	–	2
Unknown, . .	–	–	–	–	–	–	–	–	–	–	–	1	1
Totals, . .	5	2	2	2	2	3	10	4	25	18	7	5	85

The average mortality was 15 per cent. for the year. Among the American born it was 11½ per cent. and among the Canadians 32 per cent. This high mortality rate of the Canadians is perhaps explained by the virulence of infections attributable to Canadian sources, as most of these cases were among travelers from the Provinces. The mortality among the Irish, 29 per cent., is also high, and is possibly referable in part to the low vitality of these people, induced by unhygienic modes of living.

Sanitary Conditions of Homes.

The sanitary conditions under which the cases were living were classified roughly as follows: —

Excellent, ...	72
Good, ...	276
Poor, ...	131
Bad, ...	42
Questionable, ...	38
Total, ...	559

The incidence of the disease, 348 cases, or 62 per cent., among the well-to-do is noteworthy. Under present conditions the people well enough off to be traveling for their vacations or for other reasons are more likely to be infected with typhoid fever than the poorest and most ignorant in the city.

Sources of Infection.

The 559 true cases during the year 1909 can be divided into two main groups: first, those who were not away from Boston during the month preceding their sickness; second, those who returned to Boston having

probably become infected elsewhere. Some of these latter cases were sick on their arrival; others became sick shortly after reaching Boston. The distribution of these cases by months and wards is shown in the following tables: —

Local Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
January, .	–	1	2	–	–	2	1	4	4	2	–	3	3	4	2	3	2	4	–	3	–	–	2	–	–	–	42
February, .	1	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	1	7
March, .	–	4	1	–	–	1	–	–	–	–	–	–	–	–	2	–	–	1	–	–	–	3	–	–	–	–	12
April, .	–	1	–	–	1	1	–	–	–	–	–	–	1	–	1	–	1	–	–	–	–	2	1	–	–	1	10
May, .	1	3	–	3	–	2	1	–	1	–	–	1	–	2	1	–	–	–	–	–	–	1	–	2	–	–	18
June, .	–	4	–	–	–	6	–	–	1	–	–	–	1	2	–	–	1	2	–	–	–	1	–	1	–	–	19
July, .	–	–	-	–	1	–	1	2	4	–	–	–	2	1	1	–	–	–	2	1	1	–	–	–	1	–	17
August, .	2	4	4	–	7	2	–	1	1	–	2	2	–	3	1	2	1	–	2	2	2	2	1	4	2	–	47
September, .	3	3	1	2	7	1	1	3	–	1	–	1	4	2	–	–	–	1	3	5	1	–	–	–	60	–	99
October, .	3	4	4	8	3	–	1	3	–	1	2	2	1	2	1	4	2	1	4	7	2	2	–	4	7	–	68
November, .	1	1	2	5	2	2	–	–	–	1	–	2	2	2	1	–	2	3	3	4	1	3	1	2	2	–	42
December, .	–	6	–	–	–	1	–	1	–	–	–	2	2	4	–	–	–	1	1	1	4	–	–	1	–	–	24
Totals, .	11	31	17	18	21	18	5	14	11	5	4	13	16	22	10	9	9	13	15	23	12	14	5	15	72	2	405

Imported Cases.

	Wards.																									Extraneous.	Totals.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
January, .	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	4
February, .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
March, .	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	4
April, .	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
May, .	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	1	4
June, .	–	1	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	2	1	7
July, .	–	1	–	–	–	–	–	1	–	–	–	–	–	1	1	1	–	–	–	1	–	2	–	–	–	3	11
August, .	–	1	–	–	3	1	1	1	–	–	1	–	–	–	–	1	–	–	1	3	1	–	–	2	–	–	16
September, .	1	2	–	2	2	–	2	1	–	1	1	–	3	2	1	1	3	–	1	3	2	–	3	2	1	2	36
October, .	1	6	3	–	–	1	–	–	–	–	3	2	–	1	2	2	–	–	3	9	3	3	2	3	3	5	52
November, .	–	1	–	–	1	–	2	–	–	1	–	1	1	1	1	–	–	–	1	–	–	1	–	1	1	2	15
December, .	–	–	–	–	–	2	–	–	–	–	1	–	–	–	–	–	–	–	–	2	–	–	–	–	1	2	8
Totals, .	3	12	3	2	6	6	6	4	–	3	7	4	4	5	5	5	3	–	6	20	7	8	5	8	9	17	158

Of course it is impossible to trace each case with certainty. The grouping of the cases merely shows the most probable source of infection. In the following tables are shown the probable modes of infection of the local cases: —

Local Cases.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Known exposure: —													
Secondary,	11	2	3	1	2	3	4	10	6	15	7	8	72
Milk,	–	–	–	–	–	–	–	3	62	7	–	–	72
Milk (?),	–	–	–	–	–	–	–	3	1	4	3	–	11
Unknown exposure: —													
Shellfish (?),	2	–	1	1	1	4	–	1	3	4	10	1	28
Carrier (?),	1	–	–	3	1	1	–	1	2	4	4	1	18
Occupation,	2	1	1	–	1	2	1	4	1	2	–	–	15
Environment,	5	1	1	–	1	1	2	5	3	2	1	–	22
Unknown,	21	3	6	5	12	8	10	20	19	31	16	12	163
Totals,	42	7	12	10	18	19	17	47	97	69	41	22	401

Under the group "secondary" are classified the cases that were known to have been exposed to direct infection in their households or at work. Under "occupation" are grouped nurses, ward tenders, a hospital barber, etc. Under "environment" are grouped several cases of young children playing over dump heaps or dirty swimming waters, gutters, etc. Under "milk" are gathered the cases exposed to infection in Brighton. Under "milk (?)" are cases in Charlestown that were taken sick about the same time as cases in Somerville and Cambridge, supplied by what was thought to be a common infected milk. Under "shellfish (?)" are cases unexposed to other known sources of infection who, shortly before being sick, partook of shellfish which may or may not at the time have seemed spoiled. In no instance were two cases clearly traced to the same source of shellfish contamination. Under "carrier (?)" are cases not known to have been otherwise exposed to infection who were living with individuals who have had typhoid fever. In some instances this supposition was supported by a history of several sporadic cases in the household. Among the cases of unknown sources of infection are grouped those concerning whom no history could be obtained, those probably not typhoid, and those probably exposed to undetected avenues of infection. This group could probably be considerably reduced by more thorough and timely investigation.

The subdivisions of the imported cases are shown in the following table: —

Imported Cases.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Known exposure: —													
Secondary, ...	–	–	–	–	–	1	1	1	5	2	–	2	12
Milk, ...	–	–	–	–	–	–	–	–	9	28	–	–	37
Water, ...	–	–	–	1	–	1	–	–	2	3	1	–	8
Unknown exposure: —													
Shellfish (?), ...	–	–	–	–	–	1	–	1	3	1	2	1	9
Unknown, ...	4	–	4	–	4	4	10	14	17	18	12	5	92
Totals, ...	4	–	4	1	4	7	11	16	36	52	15	8	158

Study of these two groups of cases shows that of the 559 cases the source of infection of 264, or 47 per cent., was unknown; 120, or 21 per cent., were probably infected by contaminated milk; 37, or 7 per cent., were possibly infected by the eating of infected shellfish.

Milk Infections.

The milk supplied to Boston is largely furnished by four or five large milk firms. This milk is retailed by these contractors to small firms, and is also distributed widely by the contractors themselves. Much of the milk is mixed at the milk depots, to secure standard and uniform qualities. Unfortunately, this mixing of the milk from many sources greatly favors the dissemination of any infection of the milk that may have taken place. This fact was clearly shown three years ago, in January, 1907, when an explosive epidemic of over seven hundred cases of scarlet fever in four cities followed the infection of the milk of one of these contractors. The dangers of such infection are guarded against by the contractors in two ways. Some of the contractors pasteurize their milk, but this procedure, although it probably lessens the chances of a wide-spread epidemic, does not destroy the toxins generated in infected milk. Moreover, it produces a milk that deteriorates more rapidly when subsequently reinfected with bacteria. All of the firms try to guard against infected milk by careful medical inspection of the farmers and handlers of the milk. But when it is remembered that the milk of Boston is gathered from hundreds of farms in Massachusetts, New Hampshire, Maine, Vermont and New York; and when it is realized

that any individual who has ever had, is having or is about to have typhoid fever can infect this milk, and scatter sickness to hundreds of homes, the inhabitant of Boston who has received uninfected milk during the year can thank largely his good fortune. Inspection by milk firms and boards of health can lessen the chances of milk infection, but can never guarantee its purity while the milk business is conducted as it is to-day.

Reference to the chart showing the morbidity of cases by wards shows a sharp increase in the number of local cases in wards 3, 4 and 5 in October. Of these 14 unexplained cases reported from this district in October, 9, or 64 per cent., obtained their milk from stores. During September and October there occurred outbreaks of typhoid fever in Cambridge and Somerville. After investigating the epidemics in Cambridge, the milk inspector there reported that the September cases for the most part were grouped in North Cambridge, and were thought to be due to a common infected milk supply. The suspected milk was cut off from this region and put into the "run milk" of the contractor which was distributed to other dealers in Cambridge, Charlestown and Boston. The majority of the October cases in Cambridge occurred in East Cambridge, and were attributed to this same infected milk that had been shifted from a North Cambridge to an East Cambridge dealer. This sudden increase of cases in Charlestown among the store-supplied individuals, corresponding in time of morbidity to the increased number of cases in East Cambridge, suggests a common origin for the two sets of cases.

Brighton Epidemic.

Another more extensive epidemic occurred in September in Brighton. The following data regarding these cases show conclusively the milk-borne character of the epidemic.

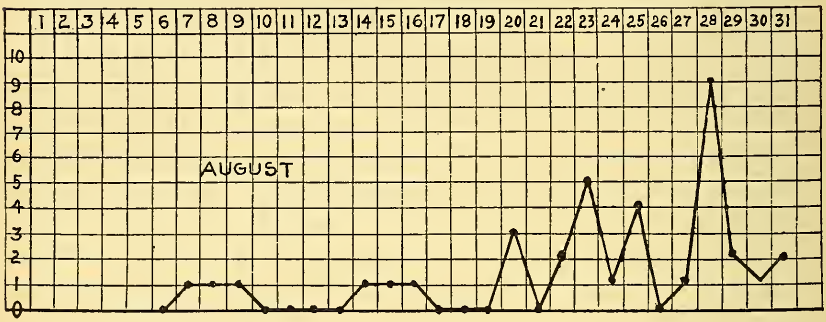
During the first week in September the number of cases of typhoid fever reported for Ward 25, the Brighton district, suddenly increased. The monthly report of the true cases of typhoid fever for this ward for the year is as follows: —

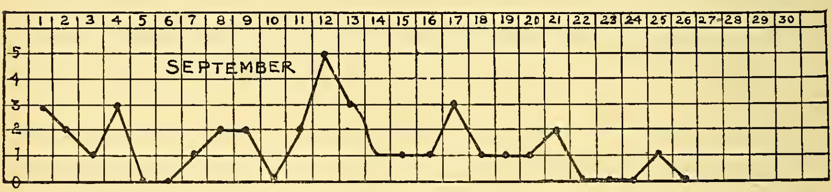
January,	1	September,	61
June,	2	October,	11
July,	1	November,	2
August,	2	December,	1

Investigation of the cause of the number of typhoid cases in this ward showed that, almost without exception, the cases were supplied by a common milkman, or had access to a common milk supply. During August, 2 cases in Ward 25 and 1 case living in Ward 11 but working

in Ward 25; during September, 57 cases in Ward 25 and 4 cases in other parts of the city temporarily residents in Ward 25; and during October, 7 cases resident in Ward 25, — a total of 71 cases, — were found to have had milk from a common source. The incidence of morbidity is shown in the following charts.

Incidence of Morbidity in Brighton Epidemic.





The sex of the cases was 32 males, and 39 females.

The age distribution of the cases was as follows: —

Under 5 years,	4	36 to 40 years,	9
6 to 10 years,	5	41 to 45 years,	4
11 to 15 years,	10	46 to 50 years,	5
16 to 20 years,	6	51 to 55 years,	1
21 to 25 years,	11	56 to 60 years,	2
26 to 30 years,	5	61 to 65 years,	1
31 to 35 years,	8	Total,	71

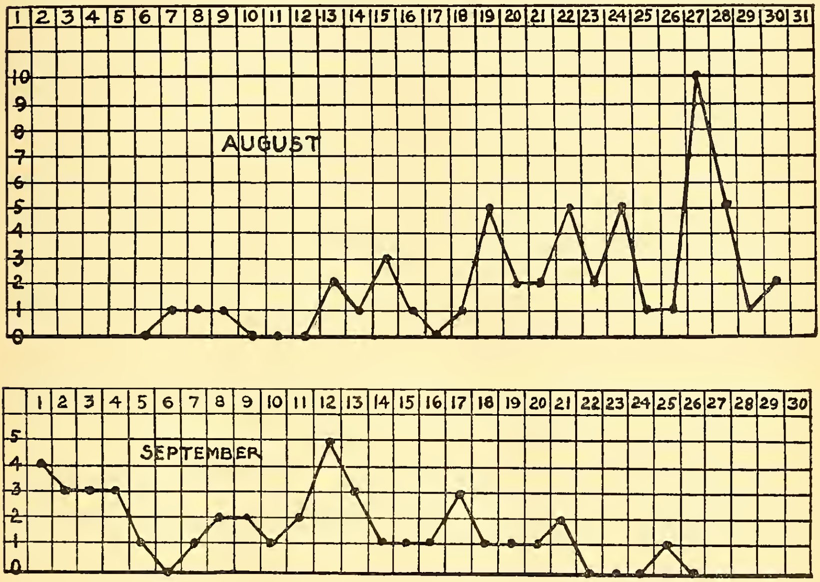
The occupations were as follows: —

Not yet in school,	3	Teamsters,	2
School,	20	Traveling salesman,	1
Housewives,	19	Iceman,	1
School teacher,	1	Railroad employees,	3
Domestic,	1	Laundrymen,	3
Physician,	1	Grocerymen,	3
Business men,	13	Total,	71

Among these cases 8 died, — a mortality of 11 per cent.

The milk suspected was delivered also in Brookline and Waltham. Here the cases of typhoid fever increased sharply in number after this time. Eighteen out of 24 cases examined in Waltham and 5 out of 8 cases in Brookline obtained milk from this infected supply. Thus 94 cases were exposed to infection from this milk. The incidence of morbidity of these cases is shown in the accompanying charts: —

Incidence of Morbidity of Brighton, Brookline and Waltham Cases.



Study of these cases shows that, although they were exposed to infection from a common milk supply, they were probably not all infected therefrom, inasmuch as the period of morbidity is drawn out over a period of more than five weeks. Among these cases are many that may have been due to secondary infection, either from other members of the family or from early cases that may have infected ice, groceries or store milk. Several of the cases had just returned to the city and may have imported their infection.

Sources of the Milk Pollution.

The suspected milk was from two sources. For the most part it came from nine farms in Wayland and Sudbury. Another portion of the milk was obtained at times during August from a Boston milk contractor.

Examination of the suspected milkman's business showed no evident source of infection among his employees or among any of the persons coming in contact with the milk from the time it was received from the farms until it was delivered. The man who capped the milk bottles gave an indefinite history of having had some sort of a fever in his childhood. No typhoid bacilli were found in a single examination of his feces and urine.

The farms producing the milk were examined repeatedly by men from the Boston board of health, and an agent of the State Board of Health made a partial examination. No cases of typhoid fever were found on these farms, and no evident source of contagion was discovered. At one farm two boys were at work who had typhoid fever in 1908, the previous fall. Repeated examinations of urine and feces from these individuals failed to show typhoid bacilli.

Another farm was situated in close proximity to a pond supplied in part by water drained from the Marlborough filter beds. Examination of this water by the Boston board of health showed it to be contaminated with fecal material, and unfit for household use. This water was not used on the farm except as drinking water for the cows while at pasture. That the cows, wading through this water, became contaminated, and that this filth was shaken into the milk pails, seems barely possible. The absence of typhoid fever at the farm itself, however, where milk was freely used, and where the pond was used as a swimming pool, makes this theory very improbable.

The sources of the milk obtained from the Boston contractor were investigated by the Boston board of health without revealing any source of the contagion. Shortly afterwards, however, infected milk said to be from the same milk train, derived from a farm on which there was a case of typhoid fever, was blamed for an outbreak of fever in Cambridge and Somerville. No absolute connection between this infected farm and the Waltham milk dealer has been found, but such a connection may have been the source of the milk contagion.

The possible sources of infection of this milk were: —

1. The sewage-polluted stream near one of the farms.

2. The milk capper, who may have had typhoid fever years ago, and who may now be an intermittent carrier.

3. The boys who had had typhoid fever last year at work on one of the farms.

4. The infected farm supplying milk to the Boston contractor, who furnished milk to the Waltham milk dealer.

Small Local Outbreaks of Typhoid Fever.

Among the local cases in Dorchester were 4 who attributed their infection to a boarding house on Dorchester Avenue, where a waiter was said to have been sick. From these cases there were 2 secondary cases.

In an East Boston Italian family 7 children were infected, one after another. Six of these cases were secondary to a primary case, who probably became infected while working away from home.

Typhoid Houses and Carriers.

In the North and West Ends two houses were found giving a history of repeated cases of typhoid fever. At one house there had been 5 or 6 children sick during the past four years. At the other house 4 children were said to have had typhoid fever during the past year. In both of these houses the hygienic conditions were exceedingly bad. But as none of the cases had gone to a hospital the diagnosis of typhoid fever was not certain. Carriers as a source of these cases were suspected.

In another family, in Dorchester, a boy was taken sick without evident source of infection. Four other members of his family, including his mother, had been sick with typhoid fever in years past.

The comparatively large number of cases in Ward 22 during the first months of the year suggests that the typhoid epidemic in that ward in 1908 is still showing its results through the action of carriers.

Among the imported cases numbered with the Boston cases are those from adjacent cities that were sent to Boston for treatment. Brookline, Somerville, Norwood and Cambridge, where there were small typhoid epidemics, thus contributed to the Boston lists.

In addition to these, there are other cases of travelers from other parts of the country, who seemingly picked up their infection elsewhere, and remained in Boston until convalescent. There is also a large number of Bostonians who returned from various parts of this country or from abroad infected in one way and another. In some instances these cases gave a history of having come from among other typhoid cases. Among such foci of infection may be mentioned Seaview, Rockport, a Maine lumber camp, a dredger in the harbor, etc. Eight cases returned from New Hampshire, 7 from Canada and 6 from Revere, Mass. Single cases of indefinite origin returned from many parts of New England. The mode of infection in many of these cases was reported to have been from bad water.

General Conclusions.

1. No control of the typhoid fever problem can be hoped for until each individual case of typhoid fever is correctly and promptly diagnosed, and reported with the least possible delay to the local board of health.

2. The cases reported as typhoid fever should be verified by blood culture or Widal tests, to insure proper diagnosis and proper resulting treatment of the patient, and to make the health records more accurate, and consequently more effective.

3. A patient suspected of having typhoid fever should be promptly isolated, and treated as a contagious case. Unless adequate care and precautions can be taken at the house, he should be removed to a hospital, both for his own good and for the safety of his family or associates.

4. No patient should be discharged from a hospital or in private practice until he understands clearly the ways in which typhoid fever is spread, and realizes that every case of typhoid fever may remain a source of contagion for an indefinite time without any symptoms of sickness.

5. Whenever possible the feces and urine of a typhoid case should be examined before he is discharged. But a negative result from such an examination should not be taken to prove that the case is not a carrier.

6. A campaign of education of the general public should be instituted, with the object of spreading broadcast the knowledge of the methods by which typhoid fever is transmitted and the ways in which it can be guarded against.

7. The extent of the typhoid morbidity in a community from year to year is at present largely a matter of chance. It should decrease as popular knowledge concerning typhoid fever increases.

8. All persons who are accustomed or forced to travel into other parts of the country, especially to the south and to Canada, or into rural districts, where the chances of getting contaminated water, milk, shellfish or other articles of diet are many, and almost impossible to guard against, and all physicians, nurses, ward tenders and hospital employees, should receive prophylactic inoculation.

TYPHOID FEVER OUTBREAK AT JEFFERSON, MASS.

On September 21 there was reported from Dorchester a case of typhoid fever that gave a history of having spent Labor Day at a hotel at Jefferson, Mass. On September 22, a case from Cambridge and on September 23 a case from East Boston were reported that gave similar histories. About this same time several other people, who had spent

Labor Day at this hotel in Jefferson, appeared at the Boston City and Carney hospitals sick with typhoid fever. An investigation of the source of these cases was immediately begun.

Among the Labor Day guests at the Mount Pleasant House in Jefferson, 60, or a few less than a tenth of the guests, were found to be infected with typhoid fever. The distribution of these cases was as follows: —

Boston: —		
Brighton,	1	
Charlestown,	4	
Dorchester,	13	
East Boston,	6	
Roxbury,	11	
South Boston,	2	
		37
Blackstone,		1
Brookline,		1
Cambridge,		6
Somerville,		1
Waltham,		1
Worcester,		4
Pawtucket, R. I.,		2
Providence, R. I.,		6
New Haven, Conn.,		1
Total,		60

Fifty-nine of these cases were distributed among 52 households. The occurrence by age periods was as follows: —

Under 10 years,	1
11 to 15 years,	7
16 to 20 years,	14
21 to 25 years,	15
26 to 30 years,	11
31 to 35 years,	6
35 to 40 years,	3
Over 40 years,	1
Total,	58

All of these cases spent a part of Sunday, September 5, and Monday, September 6, Labor Day, at the hotel together. Some of the guests came on Sunday and others left on Monday.

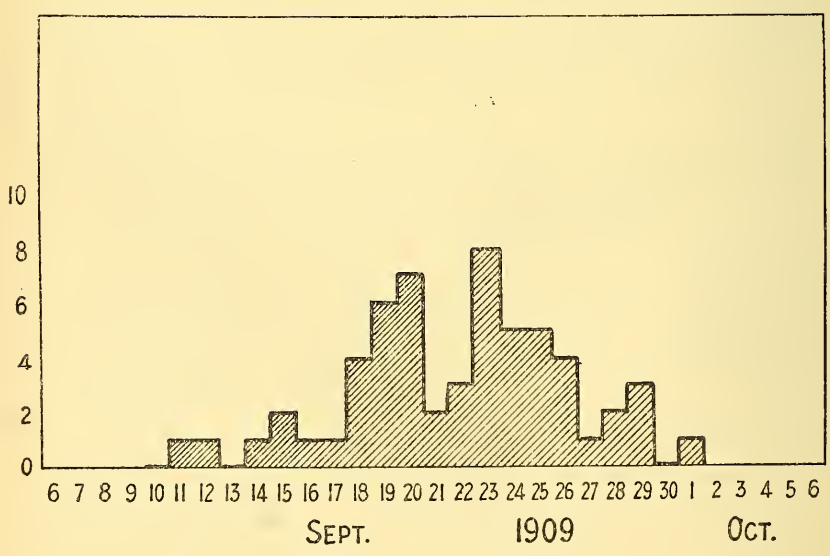
The meals taken in common by 19 of these guests, who came late or left early, were as follows: —

Sunday, September 5: —	
Breakfast,	15
Dinner,	18
Supper,	19
Monday, September 6: —	
Breakfast,	19
Dinner,	14
Supper,	9
Tuesday, September 7: —	
Breakfast,	3

No cases of typhoid fever have been reported among guests of the hotel who left on or before Sunday, September 5, or who arrived at the hotel on or subsequent to Monday morning, September 6.

The incidence of morbidity among the infected cases is shown graphically in the accompanying chart.

Incidence of Cases of Typhoid Fever as contracted at Jefferson, Mass., on Sept. 6, 1909.



Inquiry among the cases showed that they did not arrive or leave at the same time; that they were not a closely associated group, apart from the other hotel guests; that they had not been off on any expedi-

tion or party where they could have gotten food from outside the hotel. No evidence was found to suggest that infection of the cases had taken place outside of the hotel. Investigation of the conditions at the hotel showed the following facts.

The Mount Pleasant House is admirably situated on high ground overlooking Jefferson. The sewage from the hotel drains off into a valley and is there well taken care of by filter beds. There was no evidence of any break in the sewerage system or contamination of the hotel water supply. The water used by the hotel came from two sources. The hotel is supplied with the same water as Jefferson and the rest of Holden. This water was causing no typhoid fever among the people in the villages. In front of the hotel is a well, the water of which was frequently used for drinking by the hotel guests. During the summer this water had caused no sickness. Examination of the water showed no evidence of sewage contamination.

The fresh vegetables used at the hotel were supplied by a large wholesale dealer in Worcester. No evidence was found to show that the lettuce or celery used had been irrigated with sewage, or that these vegetables were causing any typhoid fever in other localities.

The milk furnished the hotel came from three sources. A small amount of it was produced on the place. No evidence of fever past or present was found among the stable men, and no source of pollution of the milk at the stable was noted. Another portion of the milk was obtained from two farms not far from the hotel. The sanitary conditions at these farms were not of the best or above criticism, but no past or present history of typhoid fever was found at either of them. The bulk of the milk was obtained from the milk train of a large Boston milk contractor. No typhoid fever was discovered among the farms furnishing this milk, and no fever was being caused by this same milk when brought down to Boston and mixed with the milk of the contractor's general supply.

Investigation among the past and present employees of the hotel showed that at the time of the investigation no one at the hotel was sick or had been recently sick with any fever suggesting typhoid fever. Among the past employees two maids were reported sick. One of these maids had been at the hotel from July 3 to September 6, when she returned to her home, seemingly in excellent health. She taught school for ten days, and then began, on September 17, to have a headache. On September 21 she went to bed, and on September 25 showed a positive Widal test. No reason was found to show that this maid had been infected before the general infection at the hotel, or that she had been the source of the outbreak. The other maid reported sick left the

hotel September 9. At that time she was feeling pretty thoroughly tired out. Saturday night, two days later, she complained of considerable thirst, and on Sunday morning she woke with a bad headache. When seen by a doctor on Wednesday, September 15, she had a temperature of 102.5, which two days later reached 103.8. The Widal reaction was found to be positive on September 22. On September 24 she was sent to St. Vincent's Hospital in Worcester. On September 28 her temperature reached normal, and remained so during an uneventful convalescence.

This case antedates by a period of from one day to two weeks all the cases supposed to have been infected at Jefferson. As it is possible for a case of typhoid fever to be a source of infection for ten days or two weeks before the onset of symptoms, there seems to be no reason why this maid, whose symptoms began September 11 or earlier, should not have been a source of infection on September 5, six days previous.

Inquiry as to the mode in which the food at the hotel might have been infected by this suspected maid disclosed the following facts: —

The bulk of the milk used at the hotel arrives at the Jefferson station at 8 A.M. Part of this milk is used by the late breakfast guests the morning of its arrival. A part of the milk that is unused during the day is kept and supplied to some of the guests the subsequent morning. When the hotel is crowded, the quantity of milk used is greater than can be stored in the hotel ice chest. Consequently some of the milk is left standing in the cans uniced during the night. The milk is transferred from the cans to pitchers with the help of long-handled ladles or dippers. These dippers are often dropped back into the cans and sometimes lost in the cans. The pitchers are filled by the several table maids, and are then placed directly on the tables or on sideboards, from which glasses are filled. The maid from whom the infection may have come was very fond of milk. For supper she was accustomed to have merely milk and cakes. The milk then used may have been taken from a partly used pitcher from the hotel supper table, from a pitcher filled by this or another maid for the servants' table, or from a glass filled by this maid directly from one of the cans. This maid also was accustomed — contrary to the rules — to get a glass of milk at bedtime. This drink of milk may have been from a glass filled from one of the cans or it may have been directly from the dipper. This maid seemingly had excellent opportunities to infect the milk, either directly by dipping her hands into it, or indirectly by polluting with her hands or mouth a dipper which was dropped back into the milk can.

Of the 60 cases of typhoid fever thought to have been contracted at Jefferson 59 were seen. Of the 59 examined, 46, or 78 per cent.,

drank the infected milk; 5, or 8 per cent., had cream on cereals or fruit; 8, or 14 per cent., had milk in tea, coffee or cocoa. Fifty-nine, or 100 per cent. of the cases examined, who were thought to have contracted typhoid fever at the Mount Pleasant House, drank the milk or had it on cereals or fruit, or in tea, coffee, or cocoa. Six of the Boston cases, or 16 per cent., died. One case that was a guest at the hotel from August 10 to September 7 is said to have overslept on the morning of Labor Day and to have had no breakfast. With this one exception all the cases of typhoid fever thought to have been exposed to infection at Jefferson probably partook of the milk served to the hotel guests on the morning of Labor Day, September 6.

The vicarious manner in which the infection was distributed among the guests seemingly is explained in part by the varying susceptibility of different individuals, and in part by the way in which the contents of one of the cans of milk used was distributed here and there among the guests in pitchers and individual glasses.

Conclusions.

1. The Jefferson typhoid outbreak was milk borne.
2. At the time the infection took place a table maid was employed at the hotel who was capable of causing the infection.
3. This maid had ample opportunity to infect a portion of the milk supplied at the hotel.
4. The infection of the milk probably took place Sunday afternoon or evening.
5. The polluted milk, after standing improperly iced all night, was thoroughly infected when served at breakfast the next morning.
6. With but one exception, all the cases infected were said to have been present at breakfast on the morning of Labor Day, September 6.
7. One hundred per cent. of the people thought to have been infected with typhoid fever at the Mount Pleasant House used milk at the hotel in one form or another.

INVESTIGATION OF TYPHOID FEVER AT MAYNARD, MASS.[1]

In September, 1905, X, a farmer of Maynard, after having been in poor health all summer, and after a two weeks' trip to Maine, was taken sick with typhoid fever. The fever ran for twenty-one days; then he had a relapse, and in all he was in bed eight weeks. In January, 1906, Mrs. X. became ill. She ran no fever and did not think she had typhoid. She was in bed but one week, and considered herself merely

[1] Disease due to milk contamination by a chronic carrier (urine).

nervously tired. Since his sickness X has been in unusually good health. He has had no jaundice and no abdominal pain.

In 1906 X began to keep two cows, and since that time cases of typhoid fever have occurred among his milk customers as follows: —

		No. of Cases.	
September,	1906,	1	
April,	1907,	2	(possibly 3)
May,	1907,	1	
June,	1908,	1	
September,	1908,	2	(possible cases said to be customers of X)
March,	1909,	1	
August,	1909,	1	
September,	1909,	2	
Total,		9	(or possibly 12 cases)

This number of cases is larger than the total number reported by the Maynard board of health for the whole town during this period.

These cases of typhoid fever have been confined to a residence portion of the town about half a mile square, centering about X's house. The region is in the better portion of the town, well elevated, with good hygienic conditions, and not close to the mills or the river.

The people are seemingly of moderate means, not foreign born, and of good intelligence. The houses have separate cesspools. There is no town sewer. The water supply is the same all through the town. The ice for the whole town comes from the same source — the river.

There is a well in the neighborhood used by a large number of people. Several of the typhoid cases did not use this well, and many other uninfected persons did get some of their drinking water there. X did not use this well.

The hygienic condition of X's place is quite unsuited for the production of milk. The cesspool is not carefully sealed. The barn is filthy and fly infested. An unguarded privy drains into the cellar, where the manure and a pig are kept. Complaints have been made by the neighbors of the smell from the place.

X has kept two cows, which have yielded him about two 8½ quart cans daily. He milks the cows and strains the milk himself. Mrs. X washes the cans. The milk is peddled about the neighborhood by X soon after it is milked. It is not iced.

No definite conclusions as to the source of the typhoid cases have been drawn. The time that has elapsed since many of the cases occurred has made the obtaining of accurate information difficult. The possibility

that X is a carrier has been considered. If he is a carrier it is more than probable that he has infected the milk. The prompt distribution of the milk may account for the small number of cases that have occurred at any one time.

Specimens of urine and stool have been obtained for examination.

Date of the investigation, Sept. 29, 1909.

Subsequent Notes.

Shortly after the above date specimens of feces and urine were obtained from X. Bacteriological examination of this material showed no typhoid bacilli in the feces, but there was an abundant growth of motile bacilli in the urine. The bacilli corresponded in cultural and agglutination characters to typhoid bacilli. A second examination of the man's urine and feces was made. The same condition was again found.

X was informed of his condition and forbidden to distribute any more milk. The board of health of Maynard was notified.

On November 4 X was given urotropin, with a dosage of 10 grains, t. i. d. At the end of about ten days a specimen of urine was examined, and showed apparently a marked decrease in the number of typhoid bacilli. Owing to complaints of discomfort, the urotropin was then discontinued for a few days. Examination of the urine at the end of this period showed a marked increase in the number of bacilli. Urotropin was then resumed, but with a dosage of 5 grains, t. i. d. Ten days later, December 3, a specimen of urine showed an apparent decrease in the bacteriological content. December 13 the urine showed a moderate number of bacilli.

On December 15 the patient was directed to discontinue the use of urotropin and take copper sulphate in one-quarter-grain capsules t. i. d. After two weeks' trial of this medication urinary examination showed no improvement in the condition.

At the beginning of the year 1910, four and a half years after his typhoid fever attack, in spite of treatment with urotropin and copper sulphate, this man shows a constant typhoid bacilluria. He has no symptoms of cystitis, and feels better than he did before being sick.

A STUDY OF SOME OF THE SPORE-BEARING ANAËROBIC BACTERIA IN MARKET MILK.[1]

By Herbert R. Brown, S.Bc.[2]

The sanitary bearing of bacteria in cows' milk has been the subject of many publications in recent years. Yet the study of individual species, aside from their relation to flavors in the industrial dairy products, has not been pursued with much thoroughness.

Notably, the anaërobes have been more or less neglected, although their capacity for the production of toxins and of putrefactive products would lead one to assume that they may be of considerable significance as producers of diseased conditions in the digestive tract.

It was therefore suggested by Prof. Theobald Smith, pathologist to the State Board of Health, that I undertake a study of the spore-bearing anaërobes as they may be found in milk offered for sale, especially during the summer season, in Boston.

Material.

The material for this research was ordinary market milk purchased at the small stores of the urban and suburban districts, which obtain their milk supplies from different contractors, who, in turn, receive their milk from dairies scattered throughout the State of Massachusetts and the neighboring States.

The milk was shipped, in accordance with legal regulations, in refrigerator cars to the contractors, who distributed it to the small dealers in wagons not supplied with cooling arrangements. The small dealers as a rule kept the milk in large supply cans surrounded by chopped ice packed in specially prepared ice boxes. There was, however, a lapse of several hours in some cases between the removal from the cars and the delivery at the suburban stations, and during this period bacterial multiplication could go on to a greater or less extent, according to the temperature of the milk. The samples collected at the small stores were received in sterile jars and transported to the laboratory in a chamber kept cold by chopped ice and salt.

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[1] Manuscript completed July, 1909.

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Methods.

On reaching the laboratory the samples of milk were heated to 80° C. for twenty minutes, to destroy the nonspore-bearing bacteria present, and then inoculated into special tubes to enrich the anaërobes, so that convenient numbers for plating could be obtained. The use of the fermentation tube for the cultivation and biological studies of anaërobes, as suggested by Theobald Smith *et al*,[1] has given a most satisfactory means of investigating the behavior of many anaërobes in the different culture media.

The conditions obtaining in such tubes furnish a favorable environment for the growth of obligate and facultative anaërobes, and the quantity of culture medium necessary to fill the tube is sufficient for the carrying out of the common biochemical tests to demonstrate the presence or absence of specific products. When the anaërobes were sufficiently developed, dilutions of the culture were made and inoculated into blood agar for plating. The blood agar used was prepared by adding to melted agar in tubes of 12 cubic centimeters each, cooled to 40° to 50° C., 1 cubic centimeter of defibrinated horse blood, or blood of some other animal, and a few drops of a 20 per cent. dextrose solution. (Only horse blood was used in these studies.) The plates used were Petri dishes, with specially prepared earthenware covers,[46] which absorb moisture and thus prevent spreading of the surface growths in the condensation water that is often found on the medium when glass-covered dishes are used. After pouring the inoculated blood agar into the Petri dishes, lots of six were placed in Bordet[45] chambers containing pyrogallol, for the absorption of oxygen. The chambers were sealed with wax made of beeswax and vaseline, and were then placed in the incubator at a constant temperature of 37° C. for about four days, when colony development was at its height. Jars other than the Bordet chamber (which is in reality a desiccator) have been used with pyrogallol, some with exhausted chambers filled with hydrogen, some with illuminating gas, etc., with varying success; because of its simplicity the Bordet chamber was used most extensively.

Sterile tissue was obtained from chloroformed guinea pigs, according to the method described by Theobald Smith,[37] by exposing the abdominal viscera with sterile instruments and tearing away convenient sized pieces of the spleen, kidneys and liver, taken in the order named with sterile forceps. The spleen and kidneys were almost without exception found to be sterile, but the liver was occasionally found to contain aërobic and sometimes anaërobic bacteria, the sources of which are uncertain. Incubation of tubes prepared in this way from three to six days was sufficient

in most cases to demonstrate infection or sterility. Liver tissue generally undergoes a slight disintegration, causing a deposit to be formed on the walls of the bulb of the fermentation tube, and this may be mistaken for aërobic growth and may necessitate a microscopic examination to prove the absence of bacteria. About 85 per cent. of the tissues used were found to be sterile, and the remaining 15 per cent. of the tubes that showed contamination contained bacteria which were probably traceable to the dust in the air, to the skin when the abdominal viscera were exposed, or to an infection of the liver itself.

Sugars. — Dextrose, lactose and saccharose were used for the special study of gas formulæ and reactions. The specific sugars were added to sugar-free bouillon without tissue in 1 per cent. quantities just before inoculating, and then steamed in an Arnold sterilizer for fifteen to twenty minutes, to mix broth and sugar and also to drive off any dissolved air that might be present. Inoculation of the tubes so treated generally resulted in rich growths that produced relatively constant and differential gas formulæ and reactions. In some cases, however, it was necessary to pass the anaërobes through a freshening process, consisting of one or two transfers from the stock cultures to fresh tissue tubes before inoculating the prepared sugar tubes, in order to insure growth; or, as was found in one or two instances, even freshened cultures might refuse to grow without tissue, and did so only after pieces of sterile tissue were added. The greater number of anaërobes, however, were found to grow well in the absence of tissue after passing through the freshening process, that served to increase the vigor of the bacilli.

Culture Media. — The culture media used consisted of fermented (sugar-free) and unfermented beef bouillon, bouillon plus tissue, coagulated blood serum, gelatin and milk. The reaction of the beef bouillon was kept at 0.8 to 1.5 per cent. acid to phenolphthalein, that of gelatin was about the same and the sterile milk was from 1.6 to 1.9 per cent. acid to the same indicator. The milk used for the cultural tests was chiefly a high-grade milk collected under the most cleanly conditions possible. This was chosen because it seldom contained anaërobes and was more easily sterilized at 100° C. than the cheaper market milk, and could be sterilized at lower temperatures when desired. Sterilization was carried out according to the method described by Theobald Smith,[1] and at 80° C. in the manner described below. Nonspore-bearing aërobes were frequently found capable of resisting temperatures from 70° to 80° C., but these were devitalized and destroyed by heating to 80° C. on two successive days, and then after the second heating by subjection to a third heating within a few hours of the second treatment. On the third and fourth days the same heat as before was applied, and

this was followed by an incubation at 37° C. for several hours, to develop any spores that might be present, and finally the milk was heated again to destroy germinating spores if present. When the general processes of sterilization were complete, the milk was incubated for a week or more to determine the sterility, after which the medium was ready for use.

The method used differed from the method of sterilization by steam at 100° C. in that the milk is heated in flasks completely immersed in water, the temperature of which is kept at 80° C. The flasks are sealed with one-hole rubber stoppers, from which small glass tubes, drawn out to capillary ends, protrude, and serve as a means of compensation for the expansion and contraction of the fluid volumes with the respective heating and cooling of the milk, thus preventing breakage of glassware, loss of time and material. The most critical point in the process of sterilization at 80° C. is the double heating on the second day, for the second application appears to destroy the already devitalized thermo-resistant bacteria. The object of using milk sterilized in this way was to obtain the medium before it had undergone any material chemical change from the application of heat.[1]

In milk sterilized at 100° C. the change of "browning" occurs, and this is usually ascribed to the caramelization of the lactose. Milk sterilized at 100° served equally as well for cultural purposes as that heated to 80°, and the only noticeable difference between the two lots was the brownish coloration of that sterilized at the higher temperature. When unusually clean milk is found it is possible to sterilize the fluid at a temperature even as low as 70°, but the care demanded and the difficulty of destroying the nonspore-bearing thermo-resistant bacteria and the spores that may be present render the method almost useless except for experimental purposes.

Gelatin. — Gelatin medium was made in the usual way, except that 15 per cent. of gelatin was added to the bouillon instead of 10 per cent., because of the high temperature of the atmosphere during the summer months, that frequently melted the medium when the tubes were incubated at room temperature. The purpose of using the solid gelatin is, of course, to observe the morphology of the growths in the deep medium,

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[1] Jensen and Plattner[2] in 1905 report the changes produced in cows' milk by the application of different temperatures. They show that the albumins are partly coagulated at 60° C., when the heating is prolonged for five hours, although a great part was not precipitated below 70° to 75°; all albumins were coagulated at 77° in one hour, at 80° in thirty minutes and at 90° in five minutes. The authors classify the first critical stage as follows: 80° C. for five minutes, 77.5° for one hour and 70° for five hours; and the second critical stage at 120° C. for five minutes and 110° for ten minutes. The minor changes produced in milk are the coagulation of the lactalbumin and the expulsion of the carbon dioxide, and the major change is produced at 130° C. for thirty minutes or at 140° for five minutes, when the casein is partly transformed into soluble nitrogenous substances that cannot be precipitated with acetic acid.

but for ordinary purposes of determining the power of liquefaction, incubation at 37° C. may be carried out, and the medium cooled in ice water after a period of forty-eight to seventy-two hours, when, if no peptonization has taken place, the gelatin will assume its original solid condition, provided it has not been repeatedly heated to the melting point so as to produce the supposed hydrolytic changes which prevent solidification.

Blood Serum. — The blood serum used consisted of available aseptically drawn horse serum, to which a small quantity of chloroform had been added as a preservative. The serum was prepared according to the method worked out by Dr. Smith and used by him in his laboratory: the serum was heated at 55° to 58° C. for one hour, to drive off the chloroform and so prevent bubbling when the medium is rendered solid by higher temperatures when applied; during the afternoon of the first day the serum was heated again, this time to 73° C. On the second day the serum was heated at 68° to 73° for thirty minutes, and then incubated overnight at 37°, to germinate any spores if present. On the third day the serum was heated at 75° to 80°, to harden the medium. Inoculations were made by the stab or puncture method.

Storage of Cultures. — The pure cultures in continual use were stored in ordinary, cotton-plugged test tubes, in the form of bouillon cultures taken from growths in beef broth plus sterile tissue. The handling of the cultures was greatly facilitated, by this method, for the spores and the spore-bearing bacilli were sedimented and could be drawn up with a capillary pipette from the depths of the tubes, and inoculated into any medium with little danger of contamination. Stock cultures were always stored in deep agar tubes kept at low temperatures. In time, bouillon cultures do not respond to inoculation into favorable media, probably because the spores have died out.

Morphology.

The isolated bacilli in the nonspore-bearing condition were all rod-shaped organisms of varying lengths and breadths, with rounded or truncated ends. On the basis of the morphology of the bacilli after the spores were formed they were divided into the following groups: —

1. Rods with centrally or excentrally placed spores.

(*a*) Without enlargement or swelling of the rods. (The bacilli in this case contained spores that were either of the same diameter as the rods or smaller.)

(*b*) With enlargement of the rods (Clostridium type).

2. Rods with terminally placed spores whose diameters exceed those of the bacilli (Plectridium type).

(*a*) Spherical or ovoid spores placed at or near the ends of the rods, that were always enlarged to accommodate the spores.

(*b*) Oval or elongated-oval spores placed at the ends of the rods and tipped off with a point of the cell membrane, forming a "spear" or "javelin" type of anaërobe.

Many of the anaërobes isolated were motile, but variations were found in the activity of the movements, some going from place to place in a very rapid manner while others were very sluggish. The movements were undulatory, rotatory and oscillatory, like those of most of the common actively motile species, and generally undulatory, with relatively acute angles to the paths, in the cases of the sluggishly motile bacilli.

The positions of the spores were largely controlled by the movements of the bacilli, for centrifugal force was brought into play by the active oscillatory and rotatory movements of the rods, causing the relatively unstable and unfixed spores when fully formed to be thrown to the ends of the rods of uniform diameter throughout, where they remained until set free by the decomposition of the cell wall, or shifted from place to place as the conditions permitted. This explains the position of the spores that were undoubtedly formed at a central or extracentral position within the rods. In several instances relatively large spores of certain species were formed at the ends of the rods, and these could not shift from the place of formation because the stromata were of smaller diameter than the spores themselves. The nonmotile bacilli isolated were found, without exception, to have centrally placed spores. Most motile anaërobes possess the power of locomotion even after the spores are apparently fully formed. When the spores are fully formed the contents of the stromata are concentrated into the ovoid bodies, and the bacilli either remain the same size or become larger, because of the compensation of the differences of osmotic pressure within the cell by the entrance of fluid from the medium to take the place formerly occupied by the protoplasm that had become transformed to form the spore. This leaves, at the most, a fluid in which the inert spores may be moved by the residual activity of the bacilli, and accordingly they will be found in different positions, but most commonly at the ends of the rods, as noted above.

The loss of the power of locomotion occurs at different times in the life history of the bacilli, some losing this property during the stage in which spores are formed, while others remain active for a considerable time after the spores are fully formed and even to the point in the process of development marked by the distension of the rods. The motility should, therefore, be determined during the early periods of development and the best and most convenient time being twenty-four hours after

inoculation, provided, of course, growth has been satisfactory. It is probable that the power of motion is lost only when the spores are completely formed, and that the bacilli that contain spores and still have powers of locomotion have not yet completed the process of spore formation. Feeble movements are sometimes noted in the case of bacilli whose cell contents stain faintly and whose outlines remain unchanged. The outline of the rods and the power of motion seem to disappear at about the same time, and probably it is at this stage that the spores are set free.

All anaërobes stained well with the ordinary dyes and with Gram's stain. The best time to determine the Gram-positive character is during the first twenty-four hours of growth, for the bacilli are often found so far advanced in the development of spores that practically no protoplasm remains to be acted upon, and a negative or a faintly positive result is obtained.

Morphology of the Colonies. — The morphological characters of the anaërobic colonies in agar plates furnish a general means of classification.

First and most commonly found is the biconvex colony, that is, one with a circular or oval disc and fusiform viewed from the edge. When these colonies appear in groups of three or more the collection often presents a rosette form, and only parts of the characteristic colonies are seen. The forms assumed by such collections are sometimes misleading, and single colonies must be found, even at the expense of replating to bring out the morphology. Both motile and nonmotile anaërobes are found in this type of colony. A slight variation of the form of the biconvex colony or collection of colonies is sometimes met with. The colony may be likened to an amœba in the process of locomotion, the pseudopodia, like threads, extending in one or more directions. Colonies of this nature can hardly form a new class for they undoubtedly belong to the biconvex type.

All those examined were surrounded by a clear, circular halo on the partly opaque blood-agar plate. That is, they were capable of hemolyzing red blood corpuscles. The degree of hemolytic activity appeared to be about the same for all species examined. The greatest amount of hemolysis was produced about an individual colony when there were but few colonies on the plate. Large numbers of colonies will cause hemolysis of the entire plate, in which case the individual power of each colony in this direction is obscured.

The second type is found in the arborescent colony. This is a colony formed of vast numbers of bacilli in chain form, but unbranched and so intertwined and twisted as to assume a character like that of a tree

or shrub void of leaves. The center is of an opaque or slightly translucent nature, according to the vigor of the growth. These colonies are generally hemolytic, and their activity in this direction depends on the final size of the colony. Pathogenic anaërobes may assume this arborescent shape but the morphology of the colony is no indication as to the pathogenicity.

Numerous aërobic bacteria possess characters in colony growth that make their identification possible, but among the anaërobes studied no such differential properties were found beyond the arborescent or biconvex types. On one plate most remarkable colonies of a "radiating"[1] type were found. The anaërobe comprising these colonies grew in chains that were enveloped in branching, sheath-like tubules. Spore-bearing and nonspore-bearing bacilli were found within the sheath-like tubules in the original colony. In subsequent cultivations the bacilli were present without the sheath.

Cultural and Biochemical Features.

Milk. — The anaërobes were grown in milk in fermentation tubes, and they acted on the medium in different ways: some, of which anaërobe M is an example, grow in the milk but cause no change in the fluid beyond a slight rise in acidity, that is insufficient to cause the precipitation of the casein; others, and especially the true putrefactive anaërobes, like A, E, L, etc., cause a rapid precipitation of the casein, and then the mass slowly becomes dissolved by the action of the proteolytic enzymes, producing clear fluids that are generally yellowish or amber in color. This is the stage noted on Table IV. as "flocculation," that follows the precipitation of the casein, and is noteworthy in this type of bacterial action on milk, for it takes on the character of a slightly opalescent flocculent mass resembling collodion in thick solution. Anaërobes C, F, I, etc., precipitate the casein but do not dissolve the mass, which slowly becomes more and more shrunken, squeezing out a cloudy, colorless, whey-like fluid. The character of the shrinkage varies with different bacilli: anaërobes B, C and F produce contractions in the casein mass that reduce it one-half to one-third of its original size; anaërobe N causes the appearance of lines of shrinkage from top to bottom of the casein mass in the branch of the fermentation tube, and anaërobe C produces transverse lines of shrinkage under similar conditions. Anaërobes N and C, while closely resembling each other in this respect, are otherwise different from each other.

[1] The term "radiating" is used to indicate a colony from which many lines of growth extending in all directions originate from a common, opaque, central colony composed in most instances of dense masses of tangled, thread-like growths.

One other type of coagulation of milk remains, and that is one tabulated as "reticular," meaning that the precipitated casein is in the form of a spongy mass produced by the simultaneous rapid rise in acidity and the precipitation of the casein at a time when gas is being rapidly evolved. All anaërobes producing as much as 100 per cent. gas in twenty-four hours' time will form this type of coagulum, but only under conditions obtaining in the fermentation tube.

In milk in which coagulation takes place and gas is produced the first change noticed is the accumulation of a small quantity of gas, followed by a change in the normal aspect to one of heavy translucence at the part just beneath the cream in the branch, caused probably by an excessively fine precipitation of the casein that is slowly becoming sedimented. Following this early precipitation of the casein is the appearance of a fine precipitate, now visible to the naked eye, then solidification of the casein in the branch, and finally a process of streaking, usually in a longitudinal direction, of the coagulum caused by shrinkage. At the final stage the unstreaked parts of the coagulated mass may be and generally are opaque, and of the same general appearance as normal milk in the fermentation tube. The anaërobes capable of digesting the proteids of the milk then attack the mass, which is broken into coarse flocculent particles of a moderately translucent nature that are suspended or partly sedimented in a yellowish fluid formed during the process of decomposition. Continued digestion and gas production go on, according to the powers of the bacillus to resist the inhibitory effects of the accumulation of waste products in the medium; complete solution of the coagulum never takes place in the fermentation tube, but in a general way it may be estimated that 75 to 90 per cent. of the mass is chemically altered.

With the exception of anaërobe M, which caused no coagulation of the milk, the reactions ranged from 2 to 9.7 per cent. acid, and in one instance — anaërobe L — to 13.3 per cent. acid to phenolphthalein in terms of a normal solution.[1] The bacteria may have produced rennet-like ferments in addition to the proteolytic ferments formed by some of them, and these would coagulate the milk, but in such cases as the anaërobes that produced complete coagulation in twenty-four hours, and also a very high acid reaction, it is quite probable that the acid present was the causal agent in the process. The only enzymes actually demonstrated in this work during the experimental studies were the proteolytic enzymes formed by some anaërobes — anaërobes A, C, E, F, L, N, P, Q — the sugar-splitting ferments, invertin, and the hemolysins produced by all.

[1] Jordan[43] states that the quantity of acid necessary to precipitate the casein varies according to the amount of casein and phosphate present, and in general the curdling of milk depends upon the degree of acidity, temperature, time of action, amount and solubility of the calcium salts present and other factors.

Products of Growth. — The products of metabolism formed by the nonputrefactive bacilli in milk were lactic, acetic and butyric acids, and gases in the proportions shown in Table III. The true putrefactive anaërobes produced the same acids in many cases, together with volatile fatty acids, and in addition there were products of proteid decomposition, such as indol, skatol, hydrogen sulphide, acid albumin and peptones or proteoses. One hitherto unreported phenomenon that seems to go hand in hand with positive biuret reactions is produced by the addition of strong (5 per cent. solution) NaOH solution to the digested fluid and allowing the mixture to stand over night at room temperature: in the morning, or after a lapse of twelve to fourteen hours, the mixed fluids are found to have assumed a bright cherry-red color, which disappears with the addition of acid and reappears to a certain extent, or as a brownish-red color, with the addition of the alkali. Milk in which *no* peptonization has occurred, as shown by negative biuret tests, does not give the color, and the nearest approach to it is a moderately deep amber color that occasionally appears.

Cream. — The cream of milk is only slightly and almost unappreciably affected. The heat of sterilization causes a coalescence of the oil droplets in the bulb and branch, and with incubation the relatively compact cream of the bulb becomes altered to a fluid that consists of large and very small oil globules. This is accomplished partly by the prolonged heating at the temperature of the thermostat and partly by the formation of glycerine and fatty acids by the bacteria, as has been reported in earlier papers by others.

Bouillon. — Anaërobic growth in bouillon in the fermentation tube presents nothing unusual, the features being merely the clouding of the branch and bulb fluid and the collection of varying quantities of gas when inoculated with certain species, provided, of course, some sugar is present.

Indol Reactions. — Positive reactions for indol were best obtained in sugar-free bouillon by inoculation of the medium from a freshened culture and incubating for eleven or twelve days. Some positive tests for indol were obtained from milk cultures, but, generally speaking, milk is not a favorable medium for the development of this product, probably because of the lactose present, for known indol-producing bacteria often fail to give a reaction when inoculated into sugar bouillon.[1]

Gelatin. — Gelatin was a valuable medium for the differentiation of cultures, but was not always favorable for bacterial growth, for some anaërobes capable of producing liquefaction refused to grow in the solid

[1] For indol tests see Table V.

medium at room temperature unless inoculated in large numbers. The character of the growths in gelatin, briefly stated, are as follows: —

Anaërobe A developed as ovoid opaque colonies in the deeper layers of gelatin in test tubes, and these slowly liquefied the surrounding medium, in a more or less uniform manner, until the wall of the tube was reached; then the liquefaction continued downward because of the sedimentation of the bacteria in the fluid, and also because of the prevailing favorable anaërobic conditions. Complete liquefaction was produced at room temperature in about nine days. Anaërobe B produced clouding of gelatin at first, and this was followed by complete liquefaction of the medium. Anaërobe C grew as hazy, punctate colonies that slowly assumed a radiating, feather-like growth that later became a uniform dense clouding throughout the medium. Gas was produced but there was no liquefaction. Anaërobe D did not grow in gelatin. Anaërobe E caused rapid liquefaction of gelatin when inoculated in large numbers. Anaërobe F grew along the line of inoculation in gelatin but caused no liquefaction. Anaërobe G did not grow in gelatin. Anaërobe H grew in gelatin first as opaque colonies, and from these developed well-defined lines of growth, thin near the primary colonies but with thickenings or nodular enlargements at distal points. These enlargements could hardly be termed secondary colonies for no radiating growths developed from them and any continued growths followed the direction of the path of the original thread. There was a copious gas production in gelatin by this anaërobe but no liquefaction. Anaërobe I produced a dense clouding of the medium and numerous gas bubbles that mechanically split the gelatin, but no liquefaction occurred. Anaërobe J produced diffuse clouding of the gelatin but no liquefaction. Anaërobe K refused to grow in solid gelatin at room temperature, but grew in flocculent clumps in gelatin incubated at 37° C.; subsequent cooling of the gelatin showed that no liquefaction had taken place, for the medium became solid at the reduced temperature of the cooling bath. When inoculated in large numbers anaërobe L caused rapid liquefaction of gelatin. The colonies formed first as spherical bodies, and from these, delicate, thread-like growths developed which later caused a diffuse clouding of the medium. Anaërobe M had no liquefying effect upon gelatin. Anaërobe N caused rapid liquefaction of gelatin. Anaërobe O, culturally very similar to anaërobe N in milk medium, caused no liquefaction but produced radiating growths and some gas in the medium. Anaërobe P caused rapid liquefaction of gelatin without any characteristic colony formation. Anaërobe Q formed punctate colonies surrounded by lines of growth resembling scintillations of light that were of only a temporary existence, for liquefaction of the gelatin rapidly followed.

Pathogenic Action. — Though it did not come within the scope of this investigation to make a thorough study of the disease-producing properties of the anaërobes isolated from milk, it was thought best to make certain simple inoculation tests with every culture. Guinea pigs were used for this purpose. One cubic centimeter of the sediment of a bouillon culture in a fermentation tube plus tissue was injected under the skin of a guinea pig. With the exception of bacillus D (*B. Welchii* or *B. aërogens capsulatus*) none was pathogenic. The tests were repeated, with the same result. This does not, of course, imply that all the anaërobes isolated are entirely harmless. Additional tests will be made upon other animals as soon as opportunity is offered.

Description of Certain Species of Anaërobes isolated from Milk, and Comparison of Cultures.[1]

Anaërobe A.[2]— This is a motile, spore-bearing bacillus. Rods without spores measure 2.5μ to 4.4μ long by 0.6μ to 0.7μ broad. Bacilli bearing spores measure 3.2μ to 4.0μ long by 0.6μ broad in the narrow parts of the rods and 1.0μ to 1.2μ broad at the parts dilated to accommodate the enclosed spore. The spores are oval in outline and measure 1.5μ to 1.9μ long by 0.9μ to 1.0μ broad. The bacilli move in either direction, in a very active manner, in undulatory or rotatory paths across the field. The spores are highly resistant to heat, being able to withstand 100° C. for over sixty minutes. This bacillus was isolated from market milk by Dr. Smith and given to me to study with the other anaërobes described in this paper. Anaërobe A acts chiefly on dextrose, forming sixty-four per cent. of gas composed of H and CO_2, in a relation to each other as 1 : 7 +. In lactose and saccharose bouillon only a few bubbles of gas were formed. The reactions of the bulb fluids in the three sugars ranged from 3 per cent. to 4.3 per cent. acid in terms of a normal solution, and those of the branches from 4 per cent. to 4.45 per cent. acid at the end of incubation, phenolphthalein being used as the indicator. The anaërobe grows as opaque colonies in gelatin, and these produce complete liquefaction in the medium in about seven days. The reaction of the gelatin after liquefaction was 7.8 per cent. acid, as compared with the original acidity of 1.5 per cent. acid to phenolphthalein. Milk in the fermentation tube was coagulated in the branch in twenty-four to forty-eight hours. Gas was slowly formed until 30 per cent. was produced. The greater part of the casein was slowly dissolved and converted into a yellowish fluid giving a positive biuret test and a positive cherry-red color reaction in twenty-four hours after the addition of 5 per cent. NaOH solution. The undissolved part of the casein mass assumed a coarse flocculent character and became moderately translucent.[3] The cream of the bulb was emulsified, that is, assumed a turbid

[1] See also tables at the end of this paper.

[2] The anaërobes described in this paper are lettered, for convenience, A to Q inclusive, and will be referred to in this way, except in cases where the bacillus is known or has been named.

[3] This condition is tabulated as "flocculation" (Table IV.).

condition of varying density, and was slightly translucent, but that in the branch was unaffected. The reaction of the milk was raised from 1.7 to 6.35 per cent. acid in the bulb and 8.2 per cent. acid in the branch. Blood serum and gelatin were liquefied. The products of growth were indol, hydrogen, carbon dioxide and possibly methane. Cultures of this anaërobe, whether grown in ordinary or sugar-free bouillon, were nonpathogenic for guinea pigs. The anaërobe is Gram-positive.

Anaërobe B (*Bacillus fecalis bovis,* n. sp.). — This bacillus, isolated from cows' milk, is found in cow dung, and when grown in artificial culture media produces odors similar to those given off from accumulations of cattle manure. I found this organism on two different occasions in cows' milk, and have since isolated it from calf feces, both when in the rectum and after discharge. The anaërobe grows on blood agar in the form of biconvex colonies which are hemolytic. The rods are fusiform, with gently tapering sides ending in blunt or rounded points. Spores when formed are generally found in the middle of the rods. Rods without spores measure 2.1μ to 4.4μ long by 0.7μ to 0.9μ broad; with spores the rods measure 2.7μ to 3.1μ long by 0.6μ to 0.7μ broad at the ends and 1.0μ broad at the spores, which were 1.3μ long by 0.9μ broad. The anaërobes are motile, passing from place to place in undulatory tracks in a sluggish or active manner, according to the age of the culture, the younger forms showing the greater activity. No gas was formed in dextrose, lactose or saccharose, but about 4 per cent. acid to phenolphthalein was produced from all three sugars when added to bouillon. Milk was coagulated and the mass was greatly contracted, but biuret tests and tests for the color reaction with NaOH solution were negative, or, at most, gave very faint and doubtful reactions. Twenty-eight to 44 per cent. of gas was produced in milk cultures, and consisted of H and CO_2 in the relation of 1:13. The cause of the production of gas in milk in the fermentation tube when inoculated with this anaërobe is obscure, because of the absence of gas in lactose bouillon; it is possible that the proteid present in milk aided in the production of more favorable anaërobic conditions, and the gas produced may have been derived from the proteid decomposition. The products definitely determined in milk medium at the completion of the incubation were lactic acid, hydrogen sulphide, acid albumin, indol and skatol, the last two being present in large quantities, as shown by the pronounced character of the reactions when specific tests were made for these products. The indol and skatol were developed in ordinary peptone broth, sugar-free peptone bouillon and milk in ten to twelve days. Hydrogen sulphide was found in bouillon cultures but not in milk at the end of the incubation period. Blood serum and gelatin were liquefied. The anaërobe is Gram-positive. It is nonpathogenic for guinea pigs.

Anaërobe C. — Anaërobe C is an actively motile, long, slender bacillus, measuring in the nonspore-bearing condition 1.9μ to 4.0μ long by 0.44μ broad. Spore-bearing bacilli measure 2.5μ to 10.7μ long by 0.3μ to 0.44μ broad. The spores are large, as compared with the diameter of the rods, are terminally placed and measure 1.3μ long by 1.0μ broad; they are slightly longer than

broad, and in outline are of an elongated oval shape, or in some cases appear as cylinders with rounded ends. The rods are extended slightly beyond the spores in the form of a sharp apex, producing the "spear" or "javelin" type described above. Bacilli in the spore-bearing and nonspore-bearing stages move in undulatory tracks, but never in a rotatory or oscillatory manner. The anaërobes develop on blood agar as biconvex hemolytic colonies, and when present in clusters, with the many pointed ends projecting from the central mass, they produce a "rosette" form of colony. Dextrose, lactose and saccharose are easily split up, forming among other products H and CO_2 in a relation to each other as 2:1. Ninety per cent. of gas was produced in all three sugars, but was most rapidly formed in dextrose bouillon. The reactions of the three sugars were raised from 5.2 per cent. to 5.65 per cent. acid to phenolphtalein. Milk in the fermentation tube was coagulated in twenty-four hours' time, and this was followed by an irregular streaking of the mass, accompanied by a lateral shrinkage producing distinct paths, along which the anaërobe acted by dissolving the casein. Gas was slowly produced during the first ninety-six hours, but more rapidly after that time until the twelfth day, when a total of 57 per cent. had accumulated. Hydrogen was in the predominance, the relation of $H:CO_2$ being as 3:2. The reaction of the fluid at the end of the incubation was 6.35 per cent. acid. H_2S was present in small quantities. No indol was formed. Lactic and butyric acids were present. Biuret tests and cherry-red color reactions with the addition of 5 per cent. NaOH solution were positive. The cream in the bulb of the fermentation tube was emulsified, but was unaffected in the branch. The products of growth determined in bouillon cultures were H_2S, lactic and butyric acids, H, CO_2, and indol, when the proper conditions were offered for its formation. No offensive odors were produced in any medium. The anaërobe grows well in gelatin in the form of small, spherical colonies, but does not liquefy the medium. Blood serum was not liquefied. It is nonpathogenic for guinea pigs. The anaërobe is Gram-positive.

Anaërobe D. — Anaërobe D is *B. aërogenes capsulatus* of Welch, or *B. Welchii.* It is pathogenic for guinea pigs, producing the characteristic lesions.[1] Blood serum and gelatin were not liquified. *B. Welchii* is Gram-positive.

Anaërobe E. — Anaërobe E is a motile, spore-bearing bacillus of the drumstick type, that grows on blood agar incubated under anaërobic conditions in the form of arborescent colonies, that always become surrounded by an hemolized area. The rods without spores measure 2.8μ to 6.1μ long by 0.6μ to 0.74μ broad. Spores are slow in developing, and are generally found after forty-eight hours' growth. They were in nearly all cases excentrally placed,

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[1] When grown in ordinary broth plus tissue, and inoculated into guinea pigs, this anaërobe produced no lesion beyond a small subcutaneous nodule that was transitory, but if grown in bouillon plus tissue that had been rendered sugar-free by fermentation with B. coli, it was pathogenic for guinea pigs, producing the characteristic lesions of *B. aërogenes capsulatus* infection. This is a phenomenon discovered by Theobald Smith, and is mentioned here with his permission, though it has not been previously described. It applies to some other anaërobes beside the one under discussion, but not included in this paper.

and the rods assumed the shape of the drumstick type of anaërobe. Rods bearing spores measure 3.0μ to 4.0μ long by 0.6μ to 0.7μ broad, by 0.9μ to 1.0μ broad at the spore enlargement; the spores within the rods measure 1.2μ to 1.6μ long by 0.9μ to 1.0μ broad. Free spores, that is, those not within the rods, measure quite constantly 1.5μ long by 0.9μ to 1.0μ broad. Both spore-bearing and nonspore-bearing bacilli move with moderate activity in undulatory, rotatory or oscillatory paths. Dextrose is easily split up, forming 100 per cent. of gas consisting of H and CO_2 in the relation to each other as 2:3. From lactose and saccharose only a fraction of a per cent. of gas was produced. The reactions of the sugar bouillon in the bulb of the fermentation tubes at the end of the incubation period were 4.65 per cent. for dextrose, 3.35 per cent. for lactose and 3 per cent. for saccharose; in the branches of the tubes the reactions were 2.8 per cent. for lactose and 3 per cent. for saccharose bouillon. Milk is slowly coagulated, and the coagulum becomes marked by longitudinal lines that later develop into lines of shrinkage; and, beginning at the margins of these lines, dissolution of the casein progresses with moderate activity until about 90 per cent. of the whole has been rendered fluid. Gas up to 16 per cent. is slowly produced. The reaction of the bulb fluid at the end of the growth was 4.55 per cent., and that of the branch was 6.4 per cent. acid in the terms of a normal solution. Biuret tests of the fluid were positive, and positive cherry-red color reactions were obtained with the addition of 5 per cent. NaOH solution. Acid albumin, H_2S, H, CO_2, indol, lactic acid and volatile offensive products were present. Blood serum and gelatin were rapidly liquefied. The anaërobe is Gram-positive. Anaërobe E is nonpathogenic for guinea pigs, whether grown in sugar-free or ordinary bouillon. A small ulcer appeared on the abdomen, accompanied by the falling away of the hair, but this lesion rapidly healed.

Anaërobe F. — Anaërobe F morphologically resembles anaërobe D, but differs from that bacillus culturally in its action on sugars, from which gas is slowly produced, six days being required to form 100 per cent. of gas, whereas *B. Welchii* forms 100 per cent. gas in twenty-four hours. The action on milk is different from that of anaërobe D. This bacillus coagulates milk into a solid mass in forty-eight hours, and the coagulum undergoes shrinkage and partial peptonization; 71 per cent. of gas is slowly produced, and accordingly there is no reticular coagulation of the casein, as is noted in the case of anaërobe D, which causes rapid coagulation accompanied by simultaneous rapid gas formation. In the gas produced from sugars and from milk, hydrogen was always in the predominance, the relation of H to CO_2 being as 2:1. Blood serum and gelatin were not liquefied. The anaërobe was without effect on guinea pigs, whether grown in sugar-free or in ordinary peptonized bouillon. Anaërobe F is Gram-positive.

Anaërobe G. — Anaërobe G is a sluggishly motile bacillus, growing in the form of biconvex colonies on blood agar. Bacilli without spores measure 2.7μ to 4.6μ long by 0.9μ to 1.2μ broad after twenty-four hours' growth. After forty-eight hours' growth the bodies of the bacilli were greatly distended, their diameter reaching in some cases 1.8μ. Spore-bearing bacilli measure 3.0μ

to 3.3μ long by 1.5μ broad, and the contained spores are 1.0μ long by 0.6μ broad. This bacillus refused to grow in the absence of tissue, and this caused some difficulty in determining gas formulæ in different sugar media. In dextrose and saccharose bouillon 100 and 96 per cent. of gas, respectively, were produced, and the relation of H to CO_2 was as 2:1. In lactose bouillon only a small bubble of gas was formed. The reactions of the sugar broths at the end of the incubation period were 5.4 per cent., 5.95 per cent. and 3.1 per cent. acid to phenolphthalein for dextrose, saccharose and lactose, respectively, all being taken from the bulbs of the fermentation tubes. Milk was slowly coagulated, and the coagulum was slowly shrunken without peptonization of the casein. One hundred per cent. of gas was produced, in which the H and CO_2 bore the same relation to each other as before, *i.e.*, 2:1. The final reaction of the expressed fluid was 7.8 per cent. acid to phenolphthalein. In general, anaërobe G resembles B. butyricus of Prazmowski, but differs from it as well as the organism described by Botkin in the non-peptonization of casein and the absence of liquefaction of gelatin.

Anaërobe G had a peculiar effect on animal tissue. The effect produced upon animal tissue in the fermentation tube, whether it is kidney, liver or spleen, by most anaërobes is to cause it to assume a brownish coloration, probably indicating a reduction of the hemoglobin. Anaërobe G, however, acted in another way, for the tissue did not change from the normal red to a brown color, but increased slightly in intensity of the red color, and after several days' incubation reached a deep salmon-red color that persisted while the tissue remained in the bouillon. The tissues were filled with bacilli and contained crystals of hematoidin. Anaërobe G was without effect on guinea pigs. Blood serum was not liquefied. There was no growth in gelatin. Anaërobe G is Gram-positive.

Anaërobe H. — Anaërobe H is identical in several cultural characters with anaërobe D, but differs from it in its morphology and its power of motion. It grows on blood agar in the form of biconvex hemolytic colonies. Bacilli without spores measure 1.8μ to 6.8μ long by 0.6μ to 0.9μ broad; bacilli with spores measure 1.8μ to 6.8μ long by 0.6μ to 0.9μ broad, and contain spores that measure 1.8μ to 1.9μ long by 0.6μ to 0.9μ broad. Free spores measure 1.8μ to 1.9μ long by 0.6μ to 1.5μ broad. The rods were never distended to accommodate the spores, but as the cells began to degenerate, dilatations of the rods were noted, and the shape assumed resembled that of an inflated balloon. Spores were rapidly formed and were always found in large numbers. They are always found about midway between the middle and the end of the rods, and so differ from anaërobe D, whose spores are always centrally placed, though occupying a large part of the rods. Spores from anaërobe D are found only by careful searching through the preparations. Dextrose, lactose and saccharose were easily split up forming 85 per cent. to 100 per cent. of gas in twenty-four to forty-eight hours, and a rise in acidity from 1.2 per cent. to 5.5 per cent. in terms of a normal solution. Butyric acid was very prominent in the sugar-bouillon cultures. When inoculated into milk in the fermentation tube the medium was changed by a rapid precipitation

of the casein, accompanied by the formation of 100 per cent. of gas that produced a reticular form of coagulation already noted and described under anaërobe D. The relation of H to CO_2 was as 2:1. There was no peptonization of the casein, as was shown by the negative biuret test. Tests for indol and hydrogen sulphide were negative. The reactions at the end of the incubation period varied from 3.4 per cent. to 3.85 per cent. in terms of a normal solution. Acid albumin was present. Nonputrefactive odors, such as sour and cheesy odors, and that of butyric acid were present. Anaërobe H was commonly found in store milk, and appeared to be the general cause of the rapid breaking down of milk when it was kept under such conditions as would favor bacterial development. It is a nonputrefactive anaërobe, acting mainly on the lactose in milk, producing gas and acids, and it strongly resembles the bacillus described by Klein[17] as *B. enteritidis sporogenes,* that has led to so much confusion with *B. Welchii* because of the similarity of the cultural characters of the two anaërobes. Blood serum was not liquefied, but large quantities of gas were formed in the serum tubes. This anaërobe is Gram-positive. It was nonpathogenic for guinea pigs when grown in ordinary unfermented and in sugar-free bouillon.

Anaërobe I. — Anaërobe I is a motile bacillus that forms centrally placed spores. It grows on blood agar in the form of biconvex hemolytic colonies that are generally found in the deeper parts of the medium. Bacilli without spores measure 3.0µ to 6.1µ long by 0.74µ to 0.9µ broad. Bacilli with spores completely formed range from 3.0µ to 5.3µ long by 0.74µ to 0.9µ broad by 1.0µ to 1.3µ broad at the spores, which in turn vary from 1.5µ to 1.9µ long by 1.0µ broad, and are located 1.2µ to 1.9µ from the more distant end of the rod. Free spores measure 1.5µ to 2.1µ long by 1.0µ to 1.3µ broad. The anaërobe fermented dextrose, lactose and saccharose, forming 100 per cent. of gas in the last two and 76 per cent. in the first sugar in forty-eight hours. The relation of H or like explosive gas to the CO_2 was as 3:1. The reactions were raised from 1.45 per cent. acid to 6.55 per cent. acid in dextrose bouillon, to 5.85 per cent. in lactose and to 6.25 per cent. in saccharose broths, all percentages being given in terms of a normal solution. The odors from sugar-bouillon cultures were of a sweet, nonoffensive nature, suggesting the presence of some ester, and accompanying this were traces of butyric acid.

The action on milk was rapid and of an unusual nature. At the end of the first twenty-four hours' incubation the casein in the branch was in the state of fine precipitation, though there was no difference in its gross appearance from that of normal milk. Up to this time no gas had been formed, but during the next twenty-four hours 100 per cent. of gas was collected. There was no reticular coagulation, as was found when anaërobe D or H was inoculated into milk for gas production, and casein precipitation occurred at distinctly different periods, while in the case of the anaërobes mentioned the two processes occurred simultaneously. The relation of H to CO_2 in the gas produced was 1.4:1, or, in general terms, hydrogen was in the predominance. Beyond an emulsification of the cream in the bulb there was no action on this constituent of the milk. Indol and H_2S were absent. Biuret

tests and color reactions with NaOH solution were negative. The acidity of the fluid at the end of the incubation was 4.2 per cent. in terms of a normal solution.

Indol and H_2S were present in sugar-free broth after eleven days' growth of this anaërobe. Gelatin was split up by gas bubbles, but the medium was not liquefied. Blood serum was not liquefied. The anaërobe was Gram-positive. Anaërobe I was nonpathogenic for guinea pigs.

Anaërobe J (*Bacillus ephemeros,* n. sp.). — Anaërobe J is an extremely long bacillus, bearing in its vegetative condition terminally placed, oval spores. It grows on blood agar in the form of biconvex hemolytic colonies that show a tendency to collect in clusters. The length of the rod and the shape of the immature spore resemble like characters of anaërobe C, though the apex of the spore end of the bacillus mentioned is sharper than that of anaërobe J. The fully formed spores of anaërobe C appear to be merely adhering to the ends of the rods, while those of anaërobe J are well within the ends of the rods, that are slightly distended for their accommodation. Soon after the concentration of the protoplasm at the ends of the rods there is but a very faint response if any at all to dyes. The rapidity with which these rods lose their protoplasm, which passes largely into the spore, may be indirectly shown by the percentages of the different forms found at different periods: at the end of twenty-four hours' growth the bacilli were grouped into 90 per cent. of bacilli without spores and 10 per cent. with spores; after forty-eight hours the bacilli without spores were reduced to 25 per cent. of the total number of types found. It is on the basis of rapid passage of the active rods into the dormant latent spores that the name "ephemeros" suggests itself, for in no other species have these rapid stages of transformation been observed.

Bacilli without spores measure 2.5μ to 4.1μ long by 0.44μ to 0.6μ broad. Bacilli with spores measure 6.2μ to 7.4μ long by 0.3μ broad and 0.6μ broad at the spores, which measure 1.3μ long by 0.6μ broad. In a few cases extraordinarily long bacilli measured 8.9μ long by 0.6μ broad. Anaërobe J acts on dextrose, lactose and saccharose, producing very small quantities of gas in the first and last and a moderate quantity in lactose; in dextrose and saccharose broth 3 and 2 per cent. of gas, respectively, were produced, and in lactose 18 per cent. was formed, composed of 15 per cent. of H and 3 per cent. of CO_2. Small quantities of gas are unsatisfactory for the demonstration of an accurate gas formula, so it may suffice to say that hydrogen was in the predominance. The reaction of the dextrose broth was raised from 1.1 per cent. to 4.6 per cent. acid in the branch and to 4.33 per cent. acid in the bulb; the bulb fluid of lactose bouillon was raised to 4.7 per cent. acid, and that of saccharose broth to 1.7 per cent. for the branch and 1.93 per cent. for the bulb. Acetic, lactic and butyric acids were present.

The action on milk was different from that of all other anaërobes. Development started within twenty-four hours of inoculation, in the form of a small quantity of gas that appeared in the branch of the fermentation tube, but there was no precipitation of the casein. The gas was slowly

developed up to the twentieth day, when 38 per cent. was present, and at this point coagulation started in the form of a very fine precipitation of the casein, which was followed by a coarse granulation that later became streaked by the subsequent contraction of the mass. At the end of thirty-seven days a total of 48 per cent. of gas had collected.[1] The final acidity of the fluid was only 2 per cent. acid in terms of a normal solution, and marks a rise of but 0.3 per cent. above the original reaction of the milk. It is supposed that the acidity alone was not responsible for the precipitation of the casein, but that some enzyme was probably present that facilitated coagulation. There was no peptonization of the casein, no indol or H_2S formed either in milk or in sugar-free bouillon. The odors given off were of a sour and cheesy nature and of the nonputrefactive class. Acid albumin was present. Anaërobe J causes a heavy clouding of gelatin, but does not liquefy the medium. Blood serum was not liquefied. The bacillus stains well with aniline dyes but is negative with Gram's stain. Anaërobe J was isolated from two samples of milk, and has since been found in the rectal contents of young, milk-fed calves. It is nonpathogenic for guinea pigs.

Anaërobe K. — Anaërobe K is merely a variety of the type represented in anaërobe H, from which it differs in a few minor characters. The colonies on blood agar are hemolytic, biconvex in outline and are fringed by short radiating hairlike processes. The bacillus is motile and acts on sugars, producing 60 per cent. to 70 per cent. of gas in twenty-four hours, and 100 per cent. of gas is produced in milk in the same time. The relation of H to CO_2 is as 3:1. The reactions of the sugar broths varied from 4 per cent. to 6.5 per cent. acid, and milk was raised to 4 per cent. acid at the end of the incubation period. Gelatin was not liquefied. Blood serum was not liquefied. There was no peptonization of the casein. Indol was formed in sugar-free broth in eleven days, but H_2S was never found. The anaërobe is Gram-positive. It is nonpathogenic for guinea pigs.

Anaërobe L. — Anaërobe L is a motile bacillus, producing terminally placed ovoid spores. It grows on blood agar in the form of arborescent hemolytic colonies. It moves actively from place to place, in undulatory, rotatory or oscillatory paths, whether it occurs singly or in the form of chains. Chain formation is common and the length of the chain may reach 120μ. The original surface colonies on solid media were extensively spreading arborescent growths, composed of a complex, matted network of threads or chains but with no branchings, and these chains were found to be encased in a sheath-like tubule of a cellulose structure. It was at first supposed that the enveloping sheath was a contaminating fungus, but neither anaërobic nor aërobic conditions were successful in developing anything of that nature. In later subcultures this unusual form disappeared, but was observed at another time when anaërobe L was isolated from another sample of milk. Bacilli without spores measure 2.1μ to 5.9μ long by 0.6μ to 0.74μ broad. Spore formation was less rapid than with other bacilli. Bacilli with spores range from 2.7μ

[1] When incubation is prolonged over four or five days it is necessary to watch the cotton plug carefully, and occasionally to replace the same with a dry sterile one, to prevent fungi from working into the culture.

to 4.6μ long by 0.6μ to 0.74μ broad by 1.0μ to 1.2μ broad at the spore, which measure 1.2μ to 1.5μ long by 0.9μ to 1.0μ broad. Free spores measure 1.2μ to 1.5μ long by 0.9μ to 1.0μ broad. Anaërobe L acts energetically on dextrose, producing 95 per cent. of gas, composed of hydrogen or explosive mixture and carbon dioxide in the relation to each other as 4:7. The reactions of dextrose broth at the end of the period of incubation ranged from 4 to 4.5 per cent. acid. In lactose and saccharose bouillon only small quantities of gas were produced, — 2 to 5 per cent., — and the reaction at the end of the growth of the cultures ranged from 2.5 to 3 per cent. acid, showing that some fermentation had gone on. The odors given off were of an offensive and putrefactive character.

Milk in the fermentation tube was completely coagulated in about forty-eight hours, after which the coagulum was streaked by irregular lines of shrinkage, the margins of these lines of fracture furnishing a starting point for the process of peptonization, which begins on the third day, or twenty-four hours after the complete coagulation of the milk. The casein mass was almost completely dissolved, leaving a faintly clouded, yellowish fluid, giving a strong biuret reaction and a deep cherry-red color reaction with the addition of NaOH solution. This fluid contained acid albumin, H_2S, acetic acid and some sugar. Tests for indol were negative. The reactions for the bulb and branch fluids from the fermentation tube were 7.2 per cent. and 7.55 per cent. acid respectively.

The colonies in gelatin were characteristic in that they assumed a thistle ball appearance because of the many radiating, thread-like processes starting from the original opaque colony. Liquefaction of the medium was slow but complete. Indol was produced only in sugar-free broth plus tissue after ten to twelve days' incubation. Blood serum was liquefied. Anaërobe L was nonpathogenic for guinea pigs. The anaërobe is Gram-positive.

Anaërobe M (*Bacillus pseudo-tetani* n. sp.). — Anaërobe M is a long, thin, actively motile bacillus, bearing in its vegetative condition terminally placed spores that are spherical in form. It grows on blood agar as hemolytic biconvex colonies. Bacilli without spores measure 2.7μ to 3.0μ long by 0.3μ broad by 0.44μ to 1.0μ broad at the spores, that in turn measure 0.44μ to 1.0μ in diameter. Free spores were of the same dimensions as the enclosed spores. The anaërobe acted on dextrose, lactose and saccharose, producing as high as 40 per cent. of gas in the first and 20 per cent. and 25 per cent. of gas in the last two sugars; the relation of H to CO_2 in the gas from dextrose bouillon was as 17:1, from lactose broth, as 7:1, and from saccharose bouillon, as 10:1, all corresponding in the small proportion of CO_2 and the large quantity of H present. The rise in acidity of the sugar broths varies from 0.2 per cent. to 0.4 per cent. acid in terms of a normal solution. The odors given off were sour and nonputrefactive in character. The growth in milk was unusual, for no coagulation occurred, even after thirty-six days' incubation at 36° C., during which time 7 per cent. of gas was produced and the acidity was raised from 1.7 per cent. to 1.9 per cent. There was no peptonization of the casein. There was no growth in nutrient gelatin and

blood serum was not liquefied. The anaërobe was Gram-negative. Indol was formed in sugar-free and in ordinary bouillon. The anaërobe is nonpathogenic for guinea pigs.

Anaërobe N. — Anaërobe N is an actively motile spore-bearing bacillus that grows on blood agar in the form of arborescent hemolytic colonies. Bacilli without spores measure 1.6μ to 4.7μ long by 0.6μ to 0.9μ broad. Bacilli with spores measure 1.9μ to 3.3μ long by 0.6μ to 1.0μ broad at the position of the spore, that ranges from 1.5μ to 1.8μ long by 0.74μ to 0.9μ broad. Free spores showed the same variation as the enclosed spores. Sugars were decomposed, but practically no gas was formed; the products of growth were lactic and acetic acids, and the reactions were as follows: in dextrose broth the reaction was raised from 1.1 per cent. acid to 2.25 per cent. in the bulb and 8.4 per cent. in the branch; in lactose broth, to 6.2 per cent. in the bulb and to 6.4 per cent. in the branch; in saccharose broth, to 2.25 per cent. acid for both bulb and branch. Milk was slowly changed by the microscopic precipitation of the casein during the first twenty-four hours, though the appearance of the bulk was the same as that of normal milk. After six days the coagulum became streaked by longitudinal lines of shrinkage. The reaction of the milk was raised to 5.7 per cent. acid. No gas was formed. Biuret tests were negative. H_2S was absent. Butyric acid was present in small quantities. The odors given off from the cultures were offensive and putrefactive in character. The anaërobe is Gram-positive. Gelatin was liquefied. Blood serum was not liquefied. Indol and H_2S were found in eleven-day cultures grown in sugar-free broth plus tissue. Anaërobe N was found to be nonpathogenic for guinea pigs.

Anaërobe O. — Anaërobe O is a long, broad, spore-bearing, club-shaped, motile bacillus that grows on blood agar in the form of biconvex hemolytic colonies. The motility is confined to the nonspore-bearing bacilli, which move in either direction in undulatory paths. Bacilli bearing spores were occasionally observed making spasmodic efforts to lunge forward, or were seen rotating slowly, without any material change in position. Spore development was rapid. Bacilli without spores measure 1.8μ to 3.1μ long by 0.6μ broad. Bacilli with spores measure 3.0μ to 4.4μ long by 0.44μ to 0.6μ broad by 0.9μ to 1.2μ broad at the spores, which in turn measure 1.0μ to 1.5μ long by 0.74μ to 1.0μ broad. Free spores measure 1.5μ to 1.8μ long by 1.0μ to 1.2μ broad. Sugars were attacked, but with practically no gas formation. The reactions of dextrose, lactose and saccharose bouillon in the branches of the fermentation tube were raised, respectively, to 3.7 per cent., 2.4 per cent. and 3.4 per cent. acid, and for the bulbs of the tubes to 3.3 per cent., 4.6 per cent. and 3.6 per cent. acid. Lactic and acetic acids were present. Milk was coagulated, streaked by lines of shrinkage, etc., in much the same way as the anaërobe just described, but there was formed 57 per cent. of gas, composed of H and CO_2, in a relation to each other as 2:1. The reaction of the milk was raised to 5.2 per cent. acid. Biuret tests were negative. H_2S and indol were found in sugar-free broth cultures after eleven days' growth at 36° C. The growth in gelatin was good, but there was no liquefaction of the medium. Blood

serum was not liquefied. The anaërobe is Gram-positive. Anaërobe O was nonpathogenic for guinea pigs.

Anaërobe P. — Anaërobe P is a motile, spore-bearing bacillus forming arborescent colonies on blood agar. The motility is confined chiefly to bacilli without spores, and these move sluggishly and in undulatory paths. Spore formation is slow. Bacilli without spores measure 2.1μ to 4.8μ long by 0.6μ to 0.9μ broad. Free spores measure 1.5μ long by 0.9μ to 1.2μ broad. The anaërobe decomposed dextrose with ease, forming 88 per cent. of gas, composed of H and CO_2 in a relation to each other as 1:4. Only 3 per cent. to 4 per cent. of gas was formed from lactose or saccharose broth. Dextrose broth gave a reaction of 3.83 per cent. acid at the end of the growth, and the two other sugars in bouillon gave 2.5 per cent. and 3 per cent. acid, respectively. A sour odor was given off from the sugar cultures. H_2S was present. The effect on milk was the production of a very fine precipitation of the casein, without any gross indication of coagulation. About 31 per cent. of gas was produced. The odors given off were very offensive, and the intensity increased with the development and diminished as the growth stopped, indicating the formation of volatile intermediate chemical products. The reaction of the bulb fluid was 8.38 per cent. acid and that of the branch was 6.9 per cent. acid to phenolphthalein. H_2S was present. Indol was absent. Acid albumin was present. Biuret tests were positive, as were color reactions with the addition of NaOH solution. Sugar was still present in the fluid. The cream in the bulb was emulsified, but that of the branch was unaffected. Indol and H_2S were formed in sugar-free bouillon after eleven days' incubation. Blood serum and gelatin were liquefied. The anaërobe stains well with aniline dyes and is positive with Gram stain. The bacillus is nonpathogenic for guinea pigs.

Anaërobe Q. — Anaërobe Q morphologically resembles anaërobe H and like types, but is culturally quite different. The anaërobe grows on blood agar in the form of biconvex hemolytic colonies. It is a motile bacillus, going from place to place in undulatory paths. Spore formation is rapid. Bacilli without spores measure 2.5μ to 5.0μ long by 0.9μ to 1.0μ broad. Bacilli with spores range from 2.4μ to 4.4μ long by 0.6μ to 1.0μ broad by 1.2μ to 1.3μ broad at the greatest diameter. The contained spores measure 1.3μ to 2.1μ long by 0.9μ to 1.0μ broad. Free spores measure 1.5μ to 1.8μ long by 0.9μ to 1.0μ broad. Anaërobe Q acts on dextrose, but slightly on lactose and not at all on saccharose, so far as gas production is concerned. The reaction of the dextrose bouillon from the bulb of the fermentation tube at the end of the incubation was 3.73 per cent. acid, while the broth from bulb and branch of the lactose bouillon was 3 per cent. acid, and that of the saccharose bouillon was 2.5 per cent. acid in terms of a normal solution. Twenty-five per cent. of gas was formed from dextrose broth, and this was composed of H and CO_2 in the relation to each other as 4:1. Milk was coagulated into the reticular type of coagulation in twenty-four hours. A total of 21 per cent. of gas was produced. The reaction of the available fluid at the end of the growth was 6.9 per cent. acid for the bulb and 6.3 per cent. acid

for the branch. Indol was absent. H_2S was present in the branch fluids but not in the bulbs of the fermentation tubes. Acid albumin was present. Sour odors were given off from the sugar cultures and offensive putrefactive odors were noticeable in milk and tissue tube cultures. Beyond an emulsification of the cream in the bulb it was unaffected by the bacillus. Biuret tests were positive, as were the NaOH color reactions. Sugar was still present at the completion of the growth in milk. Indol and H_2S were found in eleven-day-old cultures in sugar-free bouillon. Blood serum and gelatin were liquefied. The anaërobe stains well with aniline dyes and with Gram's stains. Anaërobe Q was nonpathogenic for guinea pigs.

Other Investigations on the Relation of Anaërobes to Milk.

In the discussion of the literature I have selected those papers having a general bearing on the above report, and also those of a biological character that seem to have been the result of work with pure cultures of anaërobes. Much work, chiefly from a chemical standpoint, has been done with mixed cultures, and the data tell us but little of the specific action of different bacilli.

Toch,[7] Hofmeister,[8] Dogiel[9] and others have shown that normal milk contains no peptones, and it follows that in cases where delicate reactions were obtained by the application of the biuret test the results indicated slight decomposition of the proteids present. Control tests made subsequent to the sterilization of the milk were invariably negative to the biuret tests in all the milk media used in the experiments described in this paper.

The action of bacteria on milk has been studied by chemists to a considerable extent, though they have in the majority of cases probably worked with mixed cultures; Duclaux[10] in 1900 reported on the influence of micro-organisms on milk inoculated with aërobes and tyrothrix tenuis and found that the former increased the soluble casein from 0.4 to 1.89 per cent., and the latter rendered in one case 2.57 per cent. of the total 3.9 per cent. of the casein soluble, and at another time dissolved the whole of the casein. Much research has been directed towards the putrefaction of proteids by bacteria that act in mixed rather than in pure cultures. Emmerling[11] in 1896 and 1897 used sugar-free wheat bran, and found putrefactive changes that he decided were produced by proteus vulgaris, and later he found that staphylococcus and streptococcus pyogenes were capable of decomposing egg albumin and blood fibrin. These results were later contradicted by Buchner, Leber, Frankel, Brieger and Lambert, and Rettger believes that Emmerling was unknowingly working with anaërobes. Rettger[12, 13] worked with well-known pathogenic and nonpathogenic anaërobes, and he holds that strict putrefaction

is produced by anaërobic bacteria, which may be classed according to their putrefactive powers as follows: —

1. Little or no putrefactive change or fermentation with the evolution of gas. Example, *B. tetani.*

2. Strong putrefactive action on native proteids but no fermentation. Example, *B. putrificus.*

3. Primarily fermentation organisms whose putrefactive functions are slight or absent. Example, *B. Welchii* and *B. enteritiditis sporogenes.*

4. Very marked putrefactive and fermentative properties. Example, *bacillus of malignant œdema* and *bacillus of sypmtomatic anthrax.*

Rettger found that *B. aërogenes capsulatus* produced no true putrefactive change in an egg-meat mixture, coagulated egg or serum albumin or casein. Bienstock[14, 15, 16] describes *B. termo,* which is not the same as that later described as *B. putrificus,*[15, 16] from the cultures of which he obtained mercaptan, alcohol, phenol, amine bases, peptone, leucin, lactic acid, succinic, valeric and paraoxyphenolpropionic acids. Klein[17] described *B. cadaveris sporogenes* that produced colonies in solid media similar to those formed by *B. spinosus,* or as termed in the above descriptions as arborescent colonies. Milk was coagulated and the reactions became amphoteric to slightly alkaline. The bacillus was not the same as that described by Sternberg,[18] and was nonpathogenic for laboratory animals. Sewerin[19] in 1897 made several examinations of horse manure, and isolated three varieties of tetanus, as he terms them. The descriptions are incomplete. One anaërobe described by this author corresponds in some respects with anaërobe C of this paper, but differs from it in its action on milk by the production of an alkaline reaction in the fluid. The bacilli, which were not named, were 2 to 8 micromillimeters long by 0.7μ to 0.8μ broad, and bore spores twice as broad as the rods. Rodella[20, 21] worked with anaërobes acting in the ripening of cheese, and dealt with Tyrothrix catenula of Duclaux, a bacillus of the caprionic acid group, a bacillus of the butyric acid group and with bacillus lacto-propyl butyricus, the last being very sensitive to heat and not coagulating milk except with the addition of glucose or saccharose. Rodella further discusses Tissier and Gaschings' Bacillus lacto-propyl butyricus non-liquefaciens, Weigman's Paraplectrum fœtidum and clostridium lactis, described by himself in regard to the quantity needed in the manufacture of cheese. Flügge[22] in 1894 describes several anaërobes, and discusses the possibility of their presence in the intestinal tract of infants as causes of enteric disturbances.

In conclusion, I wish to express my sincere thanks for and appreciation of the suggestions kindly offered by Dr. Theobald Smith, with whom

it has been my privilege to confer on the various phases of the work. Also, I am greatly indebted to the late Dr. Charles Harrington for the personal interest shown in this study of anaërobes in milk.

TABLE I. — *Morphological Classification of Anaërobes A to Q.*

Anaërobe.	Rods with centrally or extracentrally-placed Spores.		Rods with terminally placed Spores (Diameters greater than Rods).		Shape of Spore.	Motility.
	Without Enlargement of Rods.	With Enlargement of Rods.	Spores within and at or near End of Rods. Rods enlarged at Ends.	Spores at Ends of Rods. "Spear" or "Javelin" Shape.		
A,			+		Oval, ...	+
B,			+		Oval nearing spherical,	+
C,				+	Oval, ...	+
D,	+				Elongated oval, . .	O
E,			+		Oval, ...	+
F,	+				Slightly elongated oval,	O
G,		+	+		Oval, ...	+
H,	+ [1]				Slightly elongated oval,	+
I,		+	+		Slightly elongated oval,	+
J,				+	Oval, ...	+
K,		+			Oval, ...	+
L,			+		Oval, ...	+
M,			+		Spherical, . . .	+
N,		+	+		Elongated oval, . .	+
O,	+				Oval, ...	+
P,	+				Oval, ...	+
Q,	+				Oval, ...	+

[1] Spore near end.

TABLE II. — *Dimensions of Anaërobes.*

[*=Predominating size.]

Dimensions of Bacilli in Microns.

CULTURE.		TWENTY-FOUR HOURS' GROWTH.													FORTY-EIGHT HOURS' GROWTH.													
		BACILLI WITHOUT SPORES.			BACILLI WITH SPORES.						FREE SPORES.			BACILLI WITHOUT SPORES.			BACILLI WITH SPORES.						FREE SPORES.				Motility.
									SPORE.												SPORE.						
		Per Cent. of Total.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Breadth at Spore.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Breadth at Spore.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.		
A, ...		70	3.1–4.4	0.6	20	3.6–4.0	0.6	1.0–1.2	1.5–1.9	0.9–1.0	10	1.5–1.9	0.9–1.0		2.5–3.4	0.74		3.2–3.6	0.6	1.0–1.2	1.5–1.9	0.9–1.0		1.5–1.9	0.9–1.0		+
	*		3.6	0.6		3.6	0.6	1.0	1.5	0.9		1.5	0.9		3.0	0.74		3.4	0.6	1.0	1.5	0.9		1.6	0.9		
B, ...		100	2.1–4.4	0.74–0.9	O		None present				O	None present		75	2.1–4.4	0.74–0.9	10	2.7–3.1	0.6–0.74	1.0	1.3	0.9	15	1.3	0.9		+
	*		3.0	0.74											3.0	0.74		3.1	0.74	1.0	1.3	0.9		1.3	0.9		
C, ...		60	1.9–4.0	0.44	40	4.0–10.7	0.3–0.44	1.0	1.3	1.0							80	2.5–6.0	0.3–0.44	1.0	1.3	1.0	20	1.3	1.0		+
	*		3.6	0.44		10.7	0.3	1.0	1.3	1.0								6.0	0.3	1.0	1.3	1.0		1.3	1.0		
D, ...		80	3.0–3.8	1.0–1.5	15	4.1–5.9	1.3–1.5	1.3–1.5	1.5–2.1	1.2	5	1.8–1.9	1.5	75			20	Same as before					5				O
	*		3.4	1.0		4.4	1.5	1.5	1.9	1.2		1.9	1.5														

TABLE II. — *Dimensions of Anaërobes* — Concluded.

CULTURE.		TWENTY-FOUR HOURS' GROWTH.												FORTY-EIGHT HOURS' GROWTH.												Motility.
		BACILLI WITHOUT SPORES.			BACILLI WITH SPORES.						FREE SPORES.			BACILLI WITHOUT SPORES.			BACILLI WITH SPORES.						FREE SPORES.			
									SPORE.												SPORE.					
		Per Cent. of Total.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Breadth at Spore.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	Breadth at Spore.	Length.	Breadth.	Per Cent. of Total.	Length.	Breadth.	
E, ...		100	3.3 — 6.1	0.6 — 0.74	O		None present					None present		5	2.8 — 3.6	0.74	10	3.0 — 4.0	0.6 — 0.74	0.9 — 1.0	1.2 — 1.6	0.9 — 1.0	75	1.5	1.0	+
	*		3.3	0.6											3.3	0.74		3.0	0.6	1.0	1.5	1.0		1.5	1.0	
F, ...		90	2.1 — 3.0	0.6 — 1.0	5	2.5 — 2.7	0.9	1.0	1.5 — 1.8	1.0	5	1.5 — 1.8	1.0	100	2.4 — 4.1	0.9 — 1.2			None present					None present		O
	*		2.5	0.9		2.5	0.9	1.0	1.6	1.0		1.6	1.0		3.0	1.0										
G, ...		100	2.7 — 4.6	0.9 — 1.2			None present							85	3.0 — 4.0	1.0 — 1.8	10	3.0 — 3.3	1.5	1.5	1.0	0.6	5	1.0	0.6	+
	*		3.3	1.0											3.0	1.0		3.0	1.5	1.5	1.0	0.6		1.0	0.6	
H, ...		75	1.8 — 6.8	0.6 — 0.9	15	1.8 — 6.8	0.6 — 0.9	0.6 — 0.9	1.8 — 1.9	0.9 — 1.5	10	1.8 — 1.9	0.9 — 1.5	15			25						60			+
	*		4.0	0.6		4.0	0.9	0.9	1.8	0.9		1.8	0.9					Same as before								
I, ...		60	3.1 — 6.1	0.74 — 0.9	25	3.0 — 5.3	0.74	1.0 — 1.3	1.5 — 1.9	1.0	5			30	3.6 — 5.6	0.74 — 1.0							65	1.5 — 2.1	1.0 — 1.3	+
	*	10	Incipient spore formation																							

J, ...		90	2.5/4.1	0.44/0.6	10	6.2/8.9	0.3	0.6	1.3	0.6				25	2.5/2.8	0.3	10	6.2	0.74	1.1	1.5	0.6	65	1.3/1.5	0.6/1.2	+
	*																									
K, ...										Dimensions = same as Anaërobe H																
	*																									
L, ...		95–98	2.5/5.9	0.6/0.74	5 to 2									50	2.5/3.1	0.74	40	2.7/4.6	0.6/0.74	1.0/1.2	1.2/1.5	0.9/1.0	10	1.2/1.5	0.9/1.0	+
	*		4.4	0.6														3.3	0.74	1.2	1.3	1.0		1.5	1.0	
M, ...		65	2.7/3.0	0.3	15	3.0	0.3	0.9	0.9	0.9	20	0.9/1.1	0.9/1.1				25	3.0/3.6	0.3	0.44/1.0	0.44/1.0	0.44/1.0	75	0.44/1.0	0.44/1.0	+
	*																									
N, ...		90	3.3/4.6	0.6			None present				10	1.0/1.5	0.9	80	1.6/4.7	0.6/0.9	15	1.9/3.3	0.6/0.9	0.74/1.0	1.5/1.8	0.74/0.9	5	1.0/1.5	0.9	+
	*		3.3	0.6								1.0	0.9		3.0	0.9		3.3	0.74	0.9	1.5	0.9		1.0	0.9	
O, ...		20	1.8/3.1	0.6	40	3.0/4.4	0.44/0.6	0.9/1.2	1.0/1.5	0.74/1.0	40	1.8/1.9	1.0/1.2			Rapid spore formation								1.8/1.9	1.0/1.2	+
	*		2.4	0.6		3.3	0.6	0.9	1.5	0.9		1.8	1.2											1.8	1.2	
P, ...		78	2.1/3.4	0.6	20		Incipient spore formation				2	1.3/1.5	0.9/1.0	67	2.8/4.8	0.6/0.9	23		In process of spore formation				10	1.5	0.9/1.2	+
	*		3.3	0.6								1.5	1.0											1.5	0.9	
Q, ...		50	2.5/5.0	0.9/1.0	20	2.4/4.4	0.6/1.0	1.2/1.3	1.3/2.1	0.9/1.0	30	1.5/1.6	1.0	15	3.0/4.4	0.9/1.2	25	2.4/3.6	0.9/1.0	1.0/1.2	1.5/2.4	0.9/1.0	60	1.6/1.8	0.9/1.0	+
	*		3.3	1.0		3.3	0.9	1.2	1.6	0.9		1.6	1.0		3.6	1.0		2.4	0.9	1.0	1.5	0.9		1.6	1.0	

TABLE III. — *Action of Anaërobes on Sugars.*

Culture.	Percentage of Gas Production.			Relation $\frac{H}{CO_2}$	Reactions { (+)=Alkaline, (—)=Acid } in Percentages of Normal Solution.						Odors — Dextrose.
					Branch fluid.			Bulb fluid.			
	Dextrose.	Lactose.	Sacchar-ose.		Dextrose.	Lactose.	Sacchar-ose.	Dextrose.	Lactose.	Sacchar-ose.	
A, ...	64	Bubble	Bubble	$\frac{1}{7+}$	-	—3.55	—3.05	—4.3	—4.45	—4.1	Offensive and putrefactive.
B, ...	Bubble	Bubble	Bubble	-	—2.05 to —3.97	—3.2 to —4.13	—4.07 to —4.1	—1.35 to —3.14	—3.3 to —3.4	—3.4 to —3.55	Very offensive and putrefactive.
C, ...	90	90	90	$\frac{2}{1}$	-	-	-	—5.2	—5.25	—5.65	Sweet+trace butyric acid.
D, ...	100	94	100	$\frac{2}{1}$	-	-	-	—6.0	—6.3	—6.45	Sour+.
E, ...	100	½	½	$\frac{2}{3}$	-	—2.8	—3.0	—4.65	—3.35	—3.0	Very offensive and putrefactive.
F, ...	88	100	100	$\frac{2}{1}$	-	-	-	—6.1	—6.2	—7.15	Sour.
G, ...	100	Bubble	96	$\frac{2}{1}$	—5.4	—3.1	—5.95	—5.4	—3.1	—5.95	Sour.
H, ...	100	100	100	$\frac{2}{1}$	-	-	-	—5.0 to —6.45	—4.6 to —5.95	—5.05 to —6.35	Acetic and butyric acids.
I, ...	76	100	100	$\frac{3}{1}$	-	-	-	—6.55	—5.85	—6.25	Sweet, sour+butyric acid.

J, ...	3	18	2	$\frac{7}{1}$	—4.6	-	—1.93	—4.33	—4.7	—1.7	Acetic and butyric acids.
K, ...	53	74	59	$\frac{3}{1}$	-	-	-	—6.1	—4.25	—6.5	Sweet+butyric acid.
L, ...	95	2	5	$\frac{4}{7}$ or $\frac{1}{2(-)}$	-	—2.55	—2.9	—4.25	—2.6	—2.6	Very offensive and putrefactive.
M, ...	40	24	23	$\frac{10}{1}$ to $\frac{17}{1}$ dex.	-	-	-	—1.5	—1.3	—1.35	Sour.
N, ...	O	O	Bubble	-	—2.25	—6.4	—2.25	—8.4	—6.2	—2.25	Sour; acetic acid and slightly offensive.
O, ...	Bubble	Bubble	Bubble	-	—3.7	—2.4	—3.4	—3.3	—4.6	—3.6	Sour; acetic acid.
P, ...	88	3	4	$\frac{1}{4}$	-	—2.47	—2.27	—3.83	—2.29	—2.37	Sour; very offensive; slightly musty.
Q, ...	25	Bubble	O	$\frac{4}{1}$	-	—2.97	—2.57	—3.73	—3.02	—2.52	Sweet, sour; very offensive.

TABLE IV. — *Milk.*

+ = alkaline reaction; — = acid reaction.

Culture.	Coagulation.			Peptonization and Biuret Test.	Color Change to Cherry-red with NaOH.	Acid Albumin.	Indol.		Gas.		$\frac{H}{CO_2}$	Per Cent. Reaction.[1]		Odor.
	Positive or Negative.	Character.	Number of Days required.				Bulb or Branch.	Days consumed.	Total — Per Cent. Quantity.	Days consumed.		Branch.	Bulb.	
A,	+	Flocculation; compact; shrinkage; dissolution.	1 to 2	+	+	+	+	11	30	10		—8.2	—6.35	Putrefactive.
B,	+	Compact; shrinkage, ...	1	+(?)	+(?)	+	+	12 to 46	28	46	$\frac{1}{13}$		—9.7	Putrefactive.
C,	+	Compact; smooth, ...	2	+		+	—	12	57	12	$\frac{3}{2}$		—6.35	Sour; cheesy.
D,	+	Reticular, ...	2	—(?)	—(?)	+	—	2	100	2	$\frac{2+}{1}$		—3.95	Sour.
E,	+	Flocculation, ...	3	+	+	+	+	8	16	8		—6.4	—4.55	Putrefactive.
F,	+	Compact; smooth; shrinkage, .	2	+		+	—	8	71	8	$\frac{3+}{1}$		—5.15	Sour.
G,	+	Compact; smooth; shrinkage, .	4	—	—	+	—	9	100	9	$\frac{2+}{1}$		—7.8	Sour+butyric acid.
H,	+	Reticular, ...	1	—	—		—	1	100	1	$\frac{2}{1}$		—3.4 to —3.8	Cheesy.

I,	+	Smooth; fine; precipitate, . .	2	—	—(?)	+	—	2	100	2	3/2		—4.2	Sour.
J,	+	Fine; shrinkage, ...	15	—	—	+			48	12			—2.0	Cheesy; butyric acid.
K,	+	Reticular, ...	2	—	—	+			100	2	3/1		—4.0	Cheesy; butyric acid.
L,	+	Flocculation, ...	8	+	+	+	—	8	50	8	1/4		—13.3	Putrefactive.
M,	—		12	—	—	—			7	12		—1.5	—1.9	Slightly sour.
N,	+	Coarse; longitudinal streak, . .	5	+	—	+	Trace +	26	O	26			—5.7	Putrefactive+sour.
O,	+	Coarse; transverse streak, . .	7	—	—	+	—	20	57	20	2/1		—5.2	Cheesy.
P,	+	Slightly reticular; flocculation, .	2	+	+	+	+(?)	14	31			—6.9	—8.35	Sour.
Q,	+	Flocculation; reticular, . . .	2	+	+	+	+(?)	14	21			—6.3	—6.9	Sour.

[1] Reactions given in terms of a normal solution.

TABLE V. — *Tests for Specific Products and Action on Gelatin.*

Culture.	Indol.						Hydrogen Sulphide.						Gelatin.	
	Ordinary Peptonized Beef Bouillon.	Number of Days' Growth.	Sugar-free Peptonized Beef Bouillon.	Number of Days' Growth.	Milk.	Number of Days' Growth.	Ordinary Peptonized Beef Bouillon.	Number of Days' Growth.	Sugar-free Peptonized Beef Bouillon.	Number of Days' Growth.	Milk.	Number of Days' Growth.	Liquefaction.	Remarks.
A, ...	—	8			+	8-11	+	8			+	8	+	
B, ...	+	10	+	11	+	12	+	10	+	11	—	12	+	
C, ...	—	8	+	11	—	13	+	8	+	11	+	13	—	
D, ...	—	8			—	2	+	8			—	2	—	
E, ...	—	8			+	8	+	8			+	8	+	
F, ...	—	8			—	8	+	8			—	8		Clouding.
G, ...	—	7	+	10	—	9	—	7	+	10				No growth.
H, ...	+	8			—	2	+	8			—	2	—	Growth of radiating character; gas produced.
I, ...			+	11	—	2			+	11	—	2	—	Gas produced; clouding.
J, ...	+	12	—	12			—	12	—	12			—	Clouding.
K, ...	—	12	+	11			+	12	+	11			—	
L, ...	—	7	+	11	—	8	+	7	+	11	—	8	+	
M, ...	+	10	+	10			+	10	+	10			—	No growth.
N, ...			+	11	Trace	25			+	11	—	25	+	
O, ...			+	11	—	20			+	11			—	Fine hair-like radiating growths.
P, ...			+	11	+(?)	14			+	11			+	
Q, ...	—	2	+	11	+(?)	14	+	2	+	11			+	

TABLE VI. — *Horse Blood Serum.*

	Liquefaction.					
	Result.	Rapid.	Slow.	Gas Production.	Approximate Per Cent. of Serum liquefied.	Remarks.
A,	+	Moderate		H_2S+	85	
B,	+	Moderate			75	Undissolved mass slowly assumes a rose-red color similar to that of the biuret reaction. Odor very offensive.
C,	O					
D,	O			H_2S+		Gas was produced in large quantities.
E,	+		+	H_2S+	35	
F,	O			H_2S+		Gas was produced in moderate quantities.
G,	O					
H,	O			+		Gas was produced.
I,	O					
J,	O					
K,	O					
L,	+	+		H_2S+	50	H_2S was present. Odor was putrefactive and offensive.
M,	O					
N,	O					
O,	O					
P,	+		+	+	25	
Q,	+		+	+	50	Coagulated serum was broken up into cakes.

TABLE VII. — *Classification of Anaërobes on Basis of Gas Formulæ.*

Class.	General Description.	Proportions of $H:CO_2$.	Anaërobes represented.	Morphology of Colonies.
I	Hydrogen predominates over carbon dioxide, .	H *more* than 3 times greater than CO_2. $\frac{H}{CO_2} = \frac{4}{1}$ to $\frac{10}{1}$	M-J-Q . .	Biconvex.
		H *less* than 3 times greater than CO_2. $\frac{H}{CO_2} = \frac{2}{1}$ to $\frac{3}{1}$	C-D-F-G-H-I-K	Biconvex.
II	CO_2 predominates over hydrogen, . . .	$\frac{H}{CO_2} = \frac{1}{4}$ to $\frac{1}{7}$ CO_2 more than 3 times greater than H.	P-A . . .	Arborescent.
III	Relation of $H:CO_2$ is greater or less than unity, ...	$\frac{H}{CO_2} = \frac{1}{2(-)}$ to $\frac{2}{3}$	E-L . . .	Arborescent.
IV	Practically no gas, . .	Fraction of 1 per cent., . .	N-O-B . .	Arborescent.

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STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

A General Review of the Vital Statistics of the State.[1]

1908.

The number of deaths in the State in 1908 was 51,788, which was equivalent to a death-rate of 16.55 per 1,000 upon an estimated population of 3,129,348.

The mean death-rate of the five years 1904, 1905, 1906, 1907 and 1908 was 16.66, as compared with 16.97 for the previous five years.

The following figures are presented for the ten years ended with 1908: —

Massachusetts.

Years.	Population.[1]	Deaths.	Death-rates.	Years.	Population.[1]	Deaths.	Death-rates.
1899,	2,741,470	47,710	17.40	1904,	3,076,083	48,482	15.76
1900,	2,805,346	51,156	18.24	1905,	3,003,680	50,486	16.81
1901,	2,870,710	48,275	16.82	1906,	3,044,998	50,624	16.63
1902,	2,937,600	47,491	16.17	1907,	3,086,885	54,234	17.57
1903,	3,006,040	49,054	16.32	1908,	3,129,348	51,788	16.55

[1] Population estimated for intercensal years.

Infective Diseases.

The death-rate from the principal infective diseases in 1908 varied considerably from that of 1907. There was an increase in the number of deaths from scarlet fever, typhoid fever, measles, dysentery, whooping cough and cancer, and a decrease in the deaths from diphtheria, cholera infantum, consumption, pneumonia and cerebro-spinal meningitis. There were 3 deaths from smallpox.

[1] In 1905, portions of that part of the annual report then known as Statistical Summaries of Disease and Mortality were omitted, for reasons which seemed obvious, and since that time have been allowed to remain a year behind other portions of the report. The statistics were for the most part compiled for the year ended November 30, a part, according to the requirements of law, being compiled for the calendar year. In order that all the vital statistics published in the annual report may be uniform, it has been thought best to have the various sections end with the calendar year, the statistical year now to run from January 1 to December 31, beginning with Jan. 1, 1910. This section of the report for 1909 contains: the General Health of the State for the years ended Dec. 31, 1908 and 1909; the Weekly Mortality Returns for the year ended Nov. 30, 1909, and for the month of December, 1909; the Fatality of Certain Infective Diseases for the years ended Dec. 31, 1908 and 1909; the Official Returns of Notified Diseases Dangerous to the Public Health for the year ended Nov. 30, 1909, and for the month of December, 1909; and Official Returns of Deaths in Cities and Large Towns for the years ended Dec. 31, 1908 and 1909.

The deaths and death-rates from each of the foregoing diseases in the past five years are shown in the following table: —

Deaths and Death-rates from Certain Diseases in Massachusetts, 1904–1908.

	1904.		1905.		1906.		1907.		1908.	
	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.
Smallpox,	9	.03	2	.007	–	–	6	.019	3	.01
Diphtheria,	699	2.27	652	2.17	743	2.44	752	2.44	747	2.38
Scarlet fever,	138	.45	117	.39	135	.44	285	.92	369	1.15
Typhoid fever,	463	1.51	520	1.73	477	1.57	389	1.26	517	1.65
Measles,	160	.52	177	.59	208	.68	163	.53	331	1.06
Cholera infantum,	2,297	7.47	2,617	8.72	2,525	8.29	2,696	8.73	2,691	8.60
Consumption,	4,874	15.84	4,702	15.67	4,608	15.14	4,771	15.46	4,445	14.20
Dysentery,	184	.60	182	.60	176	.58	169	.55	225	.72
Whooping cough,	117	.38	218	.73	509	1.67	243	.79	288	.92
Pneumonia,	5,100	16.58	5,378	17.93	5,377	17.65	5,709	18.50	5,363	17.14
Cancer,	2,421	7.87	2,501	8.33	2,603	8.55	2,744	8.89	2,814	8.99
Cerebro-spinal meningitis,	165	.54	560	1.87	368	1.21	434	1.41	181	.58

In the following table a balance is presented between the deaths from the principal infective diseases in the two years 1907 and 1908, by which it appears that the sum of the deaths from these twelve causes in 1908 was lower by 387 than those of 1907 from the same causes: —

Deaths from Certain Infective Diseases in Massachusetts in 1907 and 1908.

	1907.	1908.	Increase.	Decrease.
Smallpox,	6	3	–	3
Diphtheria,	752	747	–	5
Scarlet fever,	285	369	84	–
Typhoid fever,	389	517	128	–
Measles,	163	331	168	–
Cholera infantum,	2,696	2,691	–	5
Consumption,	4,771	4,445	–	326
Dysentery,	169	225	56	–
Whooping cough,	243	288	45	–
Pneumonia,	5,709	5,363	–	346
Cancer,	2,744	2,814	70	–
Cerebro-spinal meningitis,	434	181	–	253
Totals,	18,361	17,974	551	938

Infant Mortality.

The rate of infant mortality during the year 1908 was, generally, much lower than that which prevailed during the five years 1903, 1904, 1905, 1906 and 1907, it being 133.2 for the year 1908 as compared with 135.7 for 1907, 144.7 for 1906, 141. for 1905, 133.6 for 1904, and 139.5 for 1903.

The total number of births which occurred during the year ended June 30, 1908, was 87,112, and the total deaths under one during the year ended Dec. 31, 1908, were 11,606.

For the sake of accuracy the death-rate of infants under one year old is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life" (Dr. Farr). In the following table the births in the first line are those which occurred between July 1, 1898, and June 30, 1899, inclusive, and so on through the table, the births in the last line being those for the year ended June 30, 1908.

The deaths under one in the same table are those of the calendar years ended Dec. 31, 1899, 1900, etc. The births during these ten years were 757,783, and the deaths under one year were 106,842, which is equivalent to an infant mortality-rate of 141.0 per 1,000 births for the decade. The last half of the period shows a gain over the first half, since the infantile death-rate in the last five years was 137.6 per 1,000 births, as compared with 144.7 in the first five years.

Infant Mortality, Massachusetts: 1899–1908, Ten Years.

Years.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.	Years.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.
1899, . .	71,156	10,532	148.0	1904, . .	74,791	9,992	133.6
1900, . .	72,430	11,500	159.0	1905, . .	74,387	10,519	141.4
1901, . .	72,559	9,952	137.2	1906, . .	76,730	11,106	144.7
1902, . .	71,770	10,075	140.4	1907, . .	83,230	11,293	135.7
1903, . .	73,618	10,269	139.5	1908, . .	87,112	11,606	133.2

Total births in ten years ended June 30, 1908, 757,783.
Total deaths under one in ten years ended Dec. 31, 1908, 106, 842.
Mean infantile death-rate, 141.0 per 1,000 births.

Consumption.

The total number of deaths from this cause registered in 1908 was 4,445, a decrease of 326 deaths from the number of deaths occurring from this disease in 1907. The death-rate from consumption was less in 1908 than that of any year of record.

The following figures present the deaths and death-rates, by ten-year periods, during the half century 1851–1900, and for the single years 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908: —

Deaths and Death-rates from Consumption in Massachusetts, 1851–1908.

Periods.	Deaths.	Death-rates per 10,000.	Periods.	Deaths.	Death-rates per 10,000.
1851-60,	45,252	39.9	1903,	4,531	15.1
1861-70,	45,913	34.9	1904,	4,874	15.8
1871-80,	54,039	32.7	1905,	4,702	15.7
1881-90,	58,303	29.2	1906,	4,608	15.1
1891-1900,	54,374	21.4	1907,	4,771	15.5
1901,	5,033	17.5	1908,	4,445	14.2
1902,	4,685	15.9			

Typhoid Fever.

The following table presents the deaths and death-rates of the cities from this cause during the year 1908: —

Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1908.

Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.	Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.
Newburyport,	13	8.8	Cambridge,	13	1.3
Beverly,	6	3.7	Everett,	4	1.2
Springfield,	23	2.8	Malden,	5	1.2
Lowell,	26	2.7	Somerville,	9	1.2
Boston,	158	2.6	Worcester,	14	1.0
Lawrence,	20	2.5	Quincy,	3	1.0
New Bedford,	20	2.4	Northampton,	2	1.0
Haverhill,	9	2.4	Holyoke,	5	.9
Taunton,	7	2.3	Chelsea,	3	.9
North Adams,	5	2.3	Marlborough,	1	.7
Lynn,	18	2.1	Woburn,	1	.7
Fitchburg,	7	2.1	Newton,	2	.5
Pittsfield,	5	1.8	Medford,	1	.5
Waltham,	4	1.4	Gloucester,	–	–
Fall River,	15	1.4	Chicopee,	–	–
Melrose,	2	1.3			
Brockton,	7	1.3	Total,	413	–
Salem,	5	1.3			

Death-rate for the above 33 cities, 1908, 1.9.

Following is a condensed summary from the report of 1900, from which it can be seen that up to and including the year 1907 there had

been a decided and continuous improvement in the death-rate from typhoid fever. In 1908 there was a slight increase in the death-rate. The number of deaths increased from 389 in 1907 to 517 in 1908, and occurred chiefly in Boston, Cambridge, Lowell, New Bedford and Newburyport.

Death-rates from Typhoid Fever per 10,000, 1871–1908, Massachusetts.

1871–75,	8.2	1896–1900,	2.6
1876–80,	4.2	1901–05,	1.9
1881–85,	4.1	1906,	1.6
1886–90,	4.6	1907,	1.3
1891–95,	3.4	1908,	1.7

For the entire State the death-rates from this cause in 1901, 1902, 1903, 1904, 1905, 1906, 1907 and 1908 were respectively, 1.95, 1.83, 1.75, 1.75, 1.73, 1.57, 1.26, and 1.65 per 10,000 inhabitants.

The highest death-rates from this cause among the cities appear to have occurred in Newburyport (8.8), Beverly (3.7), Springfield (2.8), Lowell (2.7) and Boston (2.6); and the lowest occurred in Newton (0.5) and Medford (0.5). Chicopee reported 5 cases, and Gloucester 12 cases of typhoid fever, with no deaths.

Diphtheria.

The following table shows the deaths and death-rates from diphtheria by five-year periods from 1876 to 1905, and for the years 1906, 1907 and 1908: —

Deaths and Death-rates from Diphtheria per 10,000, 1876–1908, Massachusetts.

Years.	Deaths.	Death-rates.	Years.	Deaths.	Death-rates.
1876–80,	13,676	15.8	1901–05,	4,259	2.9
1881–85,	8,944	9.5	1906,	743	2.4
1886–90,	8,857	8.4	1907,	752	2.4
1891–95,	7,652	6.4	1908,	747	2.4
1896–1900,	6,331	4.7			

Further and more definite information relative to diphtheria may be found in that portion of the report which relates to the production and distribution of antitoxin.

Other Preventable Diseases.

The following table presents the deaths and death-rates from measles, scarlet fever, dysentery, cholera infantum, and whooping cough for the period of forty-three years, 1866–1908: —

Deaths and Death-rates in Massachusetts per 10,000 Living from Certain Infective Diseases by Five-year Periods, 1866–1905, and for the Years 1906, 1907, and 1908.

	Measles.		Scarlet Fever.		Dysentery.		Cholera Infantum.		Whooping Cough.	
	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.
1866–70,	1,081	1.6	4,670	6.8	3,244	4.7	6,943	10.1	1,481	2.1
1871–75,	1,133	1.4	6,782	8.6	2,191	2.8	12,453	15.8	1,561	2.0
1876–80,	742	.9	3,517	4.1	2,366	2.7	9,054	10.5	1,493	1.7
1881–85,	1,007	1.1	2,504	2.7	1,601	1.7	9,894	10.5	1,213	1.3
1886–90,	1,089	1.0	1,810	1.7	1,276	1.2	10,904	10.3	1,421	1.3
1891–95,	815	.7	2,857	2.4	1,083	.9	13,426	11.2	1,445	1.2
1896–1900,	948	.7	1,358	1.0	1,434	1.1	11,865	8.9	1,465	1.1
1901–1905,	1,090	.7	1,463	1.0	970	.7	13,245	9.1	1,401	1.0
1906,	208	.7	135	.4	176	.6	2,525	8.3	509	1.7
1907,	163	.5	285	.9	169	.6	2,696	8.7	243	.8
1908,	331	1.1	369	1.2	225	.7	2,691	8.6	288	.9

The deaths from cerebro-spinal meningitis were 181, a marked decrease from the number of deaths recorded in 1907, and represented a death-rate of 0.58 per 10,000 living. In 1907 the death-rate was 1.41.

There were 5 deaths from hydrophobia during the year, 25 from tetanus, 2 from malignant pustule or charbon (anthrax), and 1 each from glanders and actinomycosis.

A General Review of the Vital Statistics of the State.

1909.

The number of deaths in the State in 1909 was 51,236, which was equivalent to a death-rate of 16.16 per 1,000 upon an estimated population of 3,172,395.

The mean death-rate of the five years 1905, 1906, 1907, 1908 and 1909 was 16.74, as compared with 16.63 for the previous five years.

The following figures are presented for the ten years ended with 1909: —

Massachusetts.

Years.	Population.[1]	Deaths.	Death-rates.	Years.	Population.[1]	Deaths.	Death-rates.
1900, . .	2,805,346	51,156	18.24	1905, . .	3,003,680	50,486	16.81
1901, . .	2,870,710	48,275	16.82	1906, . .	3,044,998	50,624	16.63
1902, . .	2,937,600	47,491	16.17	1907, . .	3,086,885	54,234	17.57
1903, . .	3,006,040	49,054	16.32	1908, . .	3,129,348	51,788	16.55
1904, . .	3,076,083	48,482	15.76	1909, . .	3,172,395	51,236	16.16

[1] Population estimated for intercensal years.

Infective Diseases.

The death-rate from the principal infective diseases in 1909 was somewhat less than that of 1908. There was a decrease in the number of deaths from diphtheria, scarlet fever, typhoid fever, measles, consumption, dysentery, whooping cough and cerebro-spinal meningitis; and an increase in the deaths from cholera infantum, pneumonia and cancer. There was 1 death from smallpox.

The deaths and death-rates from each of the foregoing diseases in the past five years are shown in the following table: —

Deaths and Death-rates from Certain Diseases in Massachusetts, 1905–1909.

	1905.		1906.		1907.		1908.		1909.	
	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.
Smallpox,	2	.007	–	–	6	.019	3	.01	1	.003
Diphtheria,	652	2.17	743	2.44	752	2.44	747	2.38	694	2.19
Scarlet fever,	117	.39	135	.44	285	.92	369	1.15	259	.82
Typhoid fever,	520	1.73	477	1.57	389	1.26	517	1.65	390	1.23
Measles,	177	.59	208	.68	163	.53	331	1.06	157	.49
Cholera infantum,	2,617	8.72	2,525	8.29	2,696	8.73	2,691	8.60	2,855	9.00
Consumption,	4,702	15.67	4,608	15.14	4,771	15.46	4,445	14.20	4,393	13.85
Dysentery,	182	.60	176	.58	169	.55	225	.72	215	.68
Whooping cough,	218	.73	509	1.67	243	.79	288	.92	250	.79
Pneumonia,	5,378	17.93	5,377	17.65	5,709	18.50	5,363	17.14	5,635	17.76
Cancer,	2,501	8.33	2,603	8.55	2,744	8.89	2,814	8.99	2,871	9.05
Cerebro-spinal meningitis,	560	1.87	368	1.21	434	1.41	181	.58	124	.39

In the following table a balance is presented between the deaths from the principal infective diseases in the two years 1908 and 1909, by which it appears that the sum of the deaths from these twelve causes in 1909 was lower by 130 than those of 1908 from the same causes: —

Deaths from Certain Infective Diseases in 1908 and 1909.

	1908.	1909.	Increase.	Decrease.
Smallpox,	3	1	–	2
Diphtheria and croup,	747	694	–	53
Scarlet fever,	369	259	–	110
Typhoid fever,	517	390	–	127
Measles,	331	157	–	174
Cholera infantum,	2,691	2,855	164	–
Consumption,	4,445	4,393	–	52
Dysentery,	225	215	–	10
Whooping cough,	288	250	–	38
Pneumonia,	5,363	5,635	272	–
Cancer,	2,814	2,871	57	–
Cerebro-spinal meningitis,	181	124	–	57
Totals,	17,974	17,844	493	623

Infant Mortality.

The rate of infant mortality during the year 1909 was, generally, much lower than that which prevailed during the five years 1904, 1905, 1906, 1907 and 1908, it being 126.8 for the year 1909, as compared with 133.2 for 1908, 135.7 for 1907, 144.7 for 1906, 141.4 for 1905, and 133.6 for 1904.

The total number of births which occurred during the year ended June 30, 1909, was 84,352, and the total deaths under one during the year ended Dec. 31, 1909, were 10,693.

For the sake of accuracy the death-rate of infants under one year old is obtained by comparing the deaths of such infants occurring in a year with the mean number of infants under one living throughout a year, and this number must "lie between the annual number of births and that number diminished by the deaths under one. It would be nearer the latter than the former number on account of the excess of deaths in the first months of life" (Dr. Farr). In the following table the births in the first line are those which occurred between July 1, 1899, and June 30, 1900, inclusive, and so on through the table, the births in the last line being those for the year ended June 30, 1909.

The deaths under one in the same table are those of the calendar years ended Dec. 31, 1900, 1901, etc. The births during these ten years were 770,979, and the deaths under one year were 107,005, which is equivalent to an infant mortality-rate of 138.8 per 1,000 births for the decade. The last half of the period shows a gain over the first half, since the infantile death-rate in the last five years was 136.1 per 1,000 births, as compared with 141.8 in the first five years.

Infant Mortality, Massachusetts: 1900–1909, Ten Years.

Years.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.	Years.	Births in Year ending June 30.	Deaths under One Year.	Death-rate under One Year per 1,000 Births.
1900, . .	72,430	11,500	159.0	1905, . .	74,387	10,519	141.4
1901, . .	72,559	9,952	137.2	1906, . .	76,730	11,106	144.7
1902, . .	71,770	10,075	140.4	1907, . .	83,230	11,293	135.7
1903, . .	73,618	10,269	139.5	1908, . .	87,112	11,606	133.2
1904, . .	74,791	9,992	133.6	1909, . .	84,352	10,693	126.8

Total births in ten years ended June 30, 1909, 770,979.
Total deaths under one in ten years ended Dec. 31, 1909, 107,005.
Mean infantile death-rate, 138.8 per 1,000 births.

Consumption.

The total number of deaths from this cause registered in 1909 was 4,393, a decrease of 52 deaths from the number of deaths occurring from this disease in 1908. The death-rate from consumption was less in 1909 than that of any year of record.

The following figures present the deaths and death-rates, by ten-year periods, during the half century 1851–1900, and for the single years 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908 and 1909.

Deaths and Death-rates from Consumption in Massachusetts, 1851–1909.

Periods.	Deaths.	Death-rates per 10,000.	Periods.	Deaths.	Death-rates per 10,000.
1851–60,	45,252	39.9	1903,	4,531	15.1
1861–70,	45,913	34.9	1904,	4,874	15.8
1871–80,	54,039	32.7	1905,	4,702	15.7
1881–90,	58,303	29.2	1906,	4,608	15.1
1891–1900,	54,374	21.4	1907,	4,771	15.5
1901,	5,033	17.5	1908,	4,445	14.2
1902,	4,685	15.9	1909,	4,393	13.9

Typhoid Fever.

The following table presents the deaths and death-rates of these cities from this cause during the year 1909: —

Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1909.

Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.	Cities.	Deaths from Typhoid Fever.	Death-rates per 10,000.
Taunton,	12	3.9	Somerville,	8	1.1
Pittsfield,	8	2.9	Haverhill,	4	1.0
North Adams,	6	2.7	Quincy,	3	.9
New Bedford,	22	2.6	Brockton,	5	.9
Fall River,	26	2.4	Worcester,	12	.9
Lawrence,	18	2.3	Fitchburg,	3	.9
Waltham,	6	2.1	Cambridge,	8	.8
Marlborough,	3	2.1	Newton,	3	.8
Woburn,	3	2.1	Beverly,	1	.7
Chelsea,	6	2.0	Medford,	1	.5
Melrose,	3	1.9	Chicopee,	1	.5
Malden,	8	1.9	Northampton,	–	–
Holyoke,	8	1.5	Gloucester,	–	–
Boston,	90	1.4	Everett,	–	–
Newburyport,	2	1.3	Salem,	–	–
Springfield,	11	1.3			
Lynn,	10	1.2	Total,	302	–
Lowell,	11	1.1			

Death-rate for the above 33 cities, 1909, 1.4.

Following is a condensed summary from the report of 1900, from which it can be seen that a decided and continuous improvement in the death-rate from typhoid fever is taking place: —

Death-rates from Typhoid Fever per 10,000, 1871–1909, Massachusetts.

1871–75,	8.2	1901–05,	1.9
1876–80,	4.2	1906,	1.6
1881–85,	4.1	1907,	1.3
1886–90,	4.6	1908,	1.7
1891–95,	3.4	1909,	1.2
1896–1900,	2.6		

For the entire State the death-rates from this cause in 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908 and 1909 were, respectively, 1.95, 1.83, 1.75, 1.75, 1.73, 1.57, 1.26, 1.65 and 1.23 per 10,000 inhabitants.

The highest death-rates from this cause among the cities appear to have occurred in Taunton (3.9), Pittsfield (2.9), North Adams (2.7) and New Bedford (2.6); and the lowest occurred in Beverly (0.7), Chicopee (0.5) and Medford (0.5). Northampton reported 16 cases, Gloucester 11 cases, Everett 23 cases and Salem 35 cases of typhoid fever, with no deaths.

Diphtheria.

The following table shows the deaths and death-rates from diphtheria by five-year periods from 1876 to 1905, and for the years 1906, 1907, 1908 and 1909: —

Deaths and Death-rates from Diphtheria per 10,000, 1876–1909, Massachusetts.

Years.	Deaths.	Death-rates.	Years.	Deaths.	Death-rates.
1876–80,	13,676	15.8	1901–05,	4,259	2.9
1881–85,	8,944	9.5	1906,	743	2.4
1886–90,	8,857	8.4	1907,	752	2.4
1891–95,	7,652	6.4	1908,	747	2.4
1896–1900,	6,331	4.7	1909,	694	2.2

Further and more definite information relative to diphtheria may be found in that portion of the report which relates to the production and distribution of antitoxin.

Other Preventable Diseases.

The following table presents the deaths and death-rates from measles, scarlet fever, dysentery, cholera infantum, and whooping cough for the period of forty-four years, 1866–1909: —

Deaths and Death-rates in Massachusetts per 10,000 Living from Certain Infective Diseases by Five-year Periods, 1866–1905, and for the Years 1906, 1907, 1908 and 1909.

	Measles.		Scarlet Fever.		Dysentery.		Cholera Infantum.		Whooping Cough.	
	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.	Deaths.	Death-rates.
1866–70,	1,081	1.6	4,670	6.8	3,244	4.7	6,943	10.1	1,481	2.1
1871–75,	1,133	1.4	6,782	8.6	2,191	2.8	12,453	15.8	1,561	2.0
1876–80,	742	.9	3,517	4.1	2,366	2.7	9,054	10.5	1,493	1.7
1881–85,	1,007	1.1	2,504	2.7	1,601	1.7	9,894	10.5	1,213	1.3
1886–90,	1,089	1.0	1,810	1.7	1,276	1.2	10,904	10.3	1,421	1.3
1891–95,	815	.7	2,857	2.4	1,083	.9	13,426	11.2	1,445	1.2
1896–1900,	948	.7	1,358	1.0	1,434	1.1	11,865	8.9	1,465	1.1
1901–1905,	1,090	.7	1,463	1.0	970	.7	13,245	9.1	1,401	1.0
1906,	208	.7	135	.4	176	.6	2,525	8.3	509	1.7
1907,	163	.5	285	.9	169	.6	2,696	8.7	243	.8
1908,	331	1.1	369	1.2	225	.7	2,691	8.6	288	.9
1909,	157	.5	259	.8	215	.7	2,855	9.0	250	.8

The deaths from cerebro-spinal meningitis were 124, a marked decrease from the number of deaths recorded in 1908, and represented a death-rate of .39 per 10,000 living. In 1908 the death-rate was .58.

There were 5 deaths from hydrophobia during the year, 30 from tetanus, 1 each from actinomycosis, glanders, malignant pustule or charbon (anthrax) and pellagra.

Returns of Disease and Mortality.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the recent reports of the Board, been presented under four different heads or groups. Since 1902, this series of statistics has been condensed as much as can be done consistently with a clear and intelligent method of presentation.

These summaries are defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They serve principally to show the seasonal prevalence of each of the chief infective diseases, and the mortality of children under five years old, in weekly periods. Beginning with the year 1875, this series of statistics has been annually reported (see page 475 of report for that year), and was first published as a summary in the report of 1883.

II. *The Reports of Certain Infective Diseases, — Diphtheria, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the reports of local boards of health forwarded during 1908 and 1909 to the State Board as cases arose. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 75, Section 52, of the Revised Laws.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III. This summary was first published in the report of 1893, page 639.

IV. *Annual Reports made under the Provisions of Chapter 75, Section 12, of the Revised Laws.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. The population of these cities and towns, as estimated in 1908 and 1909, constituted about 87

per cent. of the total population of the State. These reports are made under the requirements of the following statute: —

In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the state board of health. The form of such reports shall be prescribed and furnished by the state board of health. (Revised Laws, chapter 75, section 12.)

This summary was first presented in the report of 1894.

Note. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in Section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 75, section 52, of the Revised Laws, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 75, section 12, of the Revised Laws.

I.

The Weekly Mortality Returns.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the year ended Nov. 30, 1909, and for the month of December, 1909. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty-five years or more, and also in a publication of the Board, a weekly bulletin, since and including 1883.[1]

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of only a portion of the population, the reporting places being chiefly the cities and large towns.

The population of the cities and towns contributing to these returns

[1] The bulletin was changed from a weekly to a monthly publication in January, 1906.

during the year was 2,360,500, and for the month of December, 1909, was 2,372,487, or 74.4 and 74.8 per cent., respectively, of the total population.

The following items are embraced in this summary: —

Total deaths reported for each week.
Deaths of children under five years.
Deaths from acute lung diseases.
Deaths from consumption.
Deaths from diphtheria.
Deaths from typhoid fever.
Deaths from measles.
Deaths from cerebro-spinal meningitis.
Deaths from erysipelas.
Deaths from whooping cough.
Deaths from scarlet fever.
Deaths from influenza.
Deaths from smallpox.
Deaths from tuberculosis other than pulmonary.
Deaths from meningitis other than cerebro-spinal.
Deaths from anterior poliomyelitis.
Deaths from anthrax.
Deaths from tetanus.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

Summary Dec. 5, 1908, to Nov. 27, 1909.

	Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Tuberculosis, Pulmonary.	Tuberculosis, other than Pulmonary.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Meningitis, other than Cerebro-spinal.	Whooping Cough.	Scarlet Fever.	Erysipelas.	Influenza.	Smallpox.	Anterior. Poliomyelitis.	Anthrax.	Tetanus.
1908.																		
December 5,	699	182	102	52	–	21	4	6	2	–	5	7	–	–	–	–	–	–
12,	683	193	102	47	–	17	4	3	2	3	5	7	2	–	–	–	–	–
19,	712	218	118	69	–	13	5	6	4	2	7	5	1	–	–	–	–	–
26,	662	184	92	53	1	14	5	3	–	1	7	8	–	–	–	–	–	–
1909.																		
January 2,	733	212	137	71	1	16	6	6	1	1	4	3	–	–	–	–	–	–
9,	836	235	173	75	2	15	3	2	2	–	6	9	–	–	–	–	–	–
16,	763	221	150	64	–	20	5	2	1	4	13	1	–	–	–	–	–	–
23,	712	209	113	65	1	11	7	4	4	3	9	8	–	–	–	–	–	–
30,	728	206	120	61	–	16	1	2	2	1	4	10	–	–	–	–	–	–
February 6,	704	194	116	61	2	17	4	1	1	–	8	2	3	2	1	–	–	–
13,	753	196	123	77	4	12	3	1	4	–	5	7	4	5	–	–	–	–
20,	848	234	150	88	2	6	–	2	2	3	5	3	5	2	–	–	–	–
27,	761	233	125	45	3	13	3	–	3	1	9	4	6	3	–	–	–	–
March 6,	773	187	143	64	1	14	2	5	4	–	11	9	1	2	–	–	–	–
13,	863	232	152	80	10	12	3	6	4	1	6	6	7	7	–	–	–	–
20,	811	209	136	65	3	14	3	2	1	1	3	5	1	3	–	–	1	–
27,	758	196	141	66	1	14	–	9	–	–	5	6	6	4	–	–	–	–

April	3, ...	859	207	184	72	7	10	2	5	3	2	4	7	5	5	–	–	–	–
	10, ...	857	207	135	62	5	6	4	6	3	1	3	5	4	8	–	–	–	–
	17, ...	775	206	137	53	8	11	2	8	2	–	5	4	3	7	–	–	–	–
	24, ...	714	173	110	63	6	8	3	6	5	2	7	6	2	5	–	–	–	–
May	1, ...	707	185	96	66	3	7	4	5	2	–	6	4	3	1	–	–	–	–
	8, ...	726	174	100	78	7	8	3	6	1	1	5	5	7	1	–	–	–	–
	15, ...	748	195	112	72	8	8	–	5	2	–	1	6	5	–	–	–	–	–
	22	683	177	88	61	10	7	3	9	2	–	3	6	2	1	–	–	–	–
	29, ...	701	255	73	77	12	6	4	4	1	1	5	4	1	1	–	–	–	–
June	5, ...	651	164	68	62	11	14	5	1	1	–	5	3	3	1	–	–	–	–
	12, ...	629	150	59	53	13	9	1	3	4	–	2	8	–	1	–	–	–	–
	19, ...	650	164	69	65	11	11	3	5	1	2	2	4	1	–	–	–	–	–
	26, ...	735	192	53	49	11	4	7	5	7	–	5	3	3	1	–	–	–	–
July	3, ...	589	177	43	48	9	3	–	2	1	–	2	3	2	–	–	–	–	–
	10, ...	593	205	41	46	8	4	1	5	2	3	4	6	3	–	–	–	–	–
	17, ...	652	228	26	63	5	6	4	1	4	2	2	2	–	–	–	–	–	–
	24, ...	668	264	30	46	7	3	3	2	3	1	2	4	1	–	–	–	–	–
	31, ...	775	335	31	54	5	11	10	7	3	1	1	4	–	–	–	–	–	–
August	7, ...	733	337	30	51	5	6	3	2	5	2	1	–	1	–	–	–	–	–
	14, ...	813	349	32	51	9	4	7	1	5	2	2	–	–	–	–	–	–	1
	21, ...	786	366	21	63	10	5	2	3	3	–	3	4	1	–	–	–	–	–
	28, ...	792	353	27	65	9	14	10	–	7	2	3	5	1	–	–	–	–	–

Summary Dec. 5, 1908, to Nov. 27, 1909 — Concluded.

	Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Tuberculosis, Pulmonary.	Tuberculosis, other than Pulmonary.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Meningitis, other than Cerebro-spinal.	Whooping Cough.	Scarlet Fever.	Erysipelas.	Influenza.	Smallpox.	Anterior Poliomyelitis.	Anthrax.	Tetanus.
1909.																		
September 4,	683	286	29	44	9	4	10	–	4	–	3	3	2	–	–	–	–	–
11,	720	310	35	47	8	5	10	–	2	–	3	–	2	–	–	–	–	–
18,	711	279	39	60	10	2	7	2	2	–	4	1	1	1	–	–	–	1
25,	682	252	40	39	9	8	8	–	1	–	1	1	1	–	–	–	–	–
October 2,	655	223	31	56	12	6	11	1	5	–	2	3	1	–	–	1	–	–
9,	693	244	49	49	13	4	16	–	2	1	2	4	–	–	–	1	–	–
16,	687	223	49	59	13	8	17	2	2	–	2	3	–	1	–	1	–	–
23,	670	211	62	61	9	19	15	2	–	–	–	2	–	–	1	–	–	–
30,	673	161	64	57	4	16	17	–	1	–	3	3	1	2	–	–	–	1
November 6,	725	194	86	66	6	12	8	3	–	–	1	6	–	–	–	1	–	–
13,	665	161	89	52	12	7	17	1	3	–	1	1	1	–	–	–	–	–
20,	661	160	86	45	5	21	4	1	4	1	2	5	–	2	–	–	–	–
27,	723	185	88	70	6	12	7	2	2	1	–	-	2	2	–	–	–	–
Totals,	37,583	11,493	4,505	3,128	326	534	286	165	132	46	209	225	95	66	2	4	1	3
Weekly average,	722	221	87	60	6.2	10.3	5.5	3.2	2.5	.9	4	4.3	1.8	1.3	.04	.08	.02	.06
Rate per 1,000 deaths,	–	305.8	119.8	83.2	8.7	14.2	7.6	4.4	3.5	1.2	5.6	6.0	2.3	1.8	.05	.11	.03	.08
Rate per 1,000 population,	15.92	4.87	1.91	1.33	.14	.23	.12	.07	.06	.02	.09	.10	.04	.03	.0008	.0016	.0004	.0012

Average reporting population, ... 2,360,500

Condensed Statistics embracing the Total Deaths, Deaths under Five Years, and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts for the Year ended Nov. 30, 1909.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	37,583	722	100.00	15.92
Deaths under five years,	11,493	221	30.58	4.87
Deaths from acute lung diseases,	4,505	87	11.98	1.91
Deaths from tuberculosis, pulmonary,	3,128	60	8.32	1.33
Deaths from tuberculosis other than pulmonary,	326	6.2	0.87	0.14
Deaths from diphtheria,	534	10.3	1.42	0.23
Deaths from typhoid fever,	286	5.5	0.76	0.12
Deaths from measles,	165	3.2	0.44	0.07
Deaths from cerebro-spinal meningitis,	132	2.5	0.35	0.06
Deaths from meningitis other than cerebro-spinal,	46	0.9	0.12	0.02
Deaths from erysipelas,	95	1.8	0.23	0.04
Deaths from whooping cough,	209	4.0	0.56	0.09
Deaths from scarlet fever,	225	4.3	0.60	0.10
Deaths from influenza,	66	1.3	0.18	0.03
Deaths from smallpox,	2	0.04	0.005	0.0008
Deaths from anterior poliomyelitis,	4	0.08	0.011	0.0016
Deaths from anthrax,	1	0.02	0.003	0.0004
Deaths from tetanus,	3	0.06	0.008	0.0012

Summary Dec. 4 to Dec. 25, 1909.

1909.	Total Deaths.	Deaths under Five Years of Age.	Acute Lung Diseases.	Tuberculosis, Pulmonary.	Tuberculosis, other than Pulmonary.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Whooping Cough.	Scarlet Fever.	Erysipelas.	Influenza.
December 4,	643	136	83	55	9	20	9	1	4	1	–	6	–
11,	674	160	87	54	5	21	8	–	–	2	3	3	–
18,	714	196	86	76	10	16	7	2	1	2	–	1	–
25,	711	191	115	59	6	21	3	6	1	2	4	2	7
Totals,	2,742	683	371	244	30	78	27	9	6	7	7	12	7
Weekly average,	686	171	93	61	7.5	19.5	6.8	2.3	1.5	1.8	1.8	3	1.8
Rate per 1,000 deaths,	–	249.1	135.3	89.0	10.9	28.4	9.8	3.3	2.2	2.6	2.6	4.4	2.6
Rate per 1,000 population,	15.02	3.74	2.00	1.34	.16	.43	.15	.05	.03	.04	.04	.07	.04

Average reporting population, . . . 2,372,487

Condensed Statistics embracing the Total Deaths, Deaths under Five Years, and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts for the month of December, 1909.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	2,742	686	100.00	15.02
Deaths under five years,	683	171	24.91	3 74
Deaths from acute lung diseases,	371	93	13.53	2.00
Deaths from tuberculosis, pulmonary,	244	61	8.90	1.34
Deaths from tuberculosis other than pulmonary,	30	7.5	1.09	0.16
Deaths from diphtheria,	78	19.5	2.84	0.43
Deaths from typhoid fever,	27	6.8	0.98	0.15
Deaths from measles,	9	2.3	0.33	0.05
Deaths from cerebro-spinal meningitis,	6	1.5	0.22	0.03
Deaths from whooping cough,	7	1.8	0.26	0.04
Deaths from scarlet fever,	7	1.8	0.26	0.04
Deaths from erysipelas,	12	3.0	0.44	0.07
Deaths from influenza,	7	1.8	0.26	0.04

II.

Fatality of Certain Infective Diseases.

Since the year 1891 the following statistics relative to the fatality of certain diseases have been gathered from the published reports of local boards of health. Until the passage of the law in 1893 this was the only source from which figures could be obtained on which to base the fatality of diseases as compared with cases. When the law (chapter 302, Acts of 1893) requiring local boards of health to report all cases of contagious diseases to the State Board of Health first went into effect very few returns were made, and it was not until after public notice had been given by the State Board to every board of health throughout the State that these returns came in with any regularity. The practice by the local boards of health of reporting cases of contagious diseases is now so well established, and the returns are so complete, it is no longer deemed necessary to continue the former method of basing the fatality of certain contagious diseases on the figures obtained through the annual reports of local boards, but, instead, to make use of the more complete returns as received from day to day at this office.

The diseases embraced in this summary in 1908 and 1909 are diphtheria, scarlet fever, typhoid fever and measles.

The tabular list of cities and towns is omitted in this report. The summary of the figures for 1908 is as follows: —

Reported cases of diphtheria for the State,	9,108
Registered deaths from diphtheria,	747
Fatality (per cent.),	8.2

Reported cases of scarlet fever for the State,	7,994
Registered deaths from scarlet fever,	369
Fatality (per cent.),	4.6

Reported cases of typhoid for the State,	3,736
Registered deaths from typhoid fever,	517
Fatality (per cent.),	13.8

Reported cases of measles for the State,	21,470
Registered deaths from measles,	331
Fatality (per cent.),	1.5

The following table presents the summary of these statistics for the eighteen years 1891–1908: —

Reported Cases of Infective Diseases in Massachusetts.

Diphtheria.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria.

[Antitoxin Period.]

	1907.	1908.	Total 1895–1908.
Reported cases,	8,962	9,108	106,088
Deaths,	752	747	12,145
Fatality (per cent.),	8.4	8.2	11.4

Reported Cases of Infective Diseases in Massachusetts — Concluded.

Scarlet Fever.

	1907.	1908.	Total 1891-1908.
Reported cases,	7,931	7,994	97,190
Deaths,	285	369	4,956
Fatality (per cent.),	3.6	4.6	5.1

Typhoid Fever.

	1907.	1908.	Total 1891-1908.
Reported cases,	2,290	3,736	46,674
Deaths,	389	517	8,064
Fatality (per cent.),	17.0	13.8	17.3

Measles.

	1907.	1908.	Total 1891-1908.
Reported cases,	6,487	21,470	161,015
Deaths,	163	331	2,315
Fatality (per cent.),	2.5	1.5	1.4

In the foregoing tables the statistics relating to diphtheria have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. For the latter period the figures for 1907 and 1908 are given and the total for the fourteen years 1895 to 1908, inclusive. The mean fatality in the former period (1891–1894) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1908) it was 11.4 per cent., or less than half as large.

The summary of the figures for 1909 is as follows: —

Reported cases of diphtheria for the State,	7,702
Registered deaths from diphtheria,	694
Fatality (per cent.),	9.0
Reported cases of scarlet fever for the State,	7,216
Registered deaths from scarlet fever,	259
Fatality (per cent.),	3.6
Reported cases of typhoid for the State,	2,743
Registered deaths from typhoid fever,	390
Fatality (per cent.),	14.2

Reported cases of measles for the State,	15,060
Registered deaths from measles,	157
Fatality (per cent.),	1.0

The following table presents the summary of these statistics for the nineteen years 1891–1909: —

Reported Cases of Infective Diseases in Massachusetts.

Diphtheria.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria.

[Antitoxin Period.]

	1908.	1909.	Total 1895–1909.
Reported cases,	9,108	7,702	113,790
Deaths,	747	694	12,839
Fatality (per cent.),	8.2	9.0	11.3

Scarlet Fever.

	1908.	1909.	Total 1891–1909.
Reported cases,	7,994	7,216	104,406
Deaths,	369	259	5,215
Fatality (per cent.),	4.6	3.6	5.0

Typhoid Fever.

Reported cases,	3,736	2,743	49,417
Deaths,	517	390	8,454
Fatality (per cent.),	13.8	14.2	17.1

Measles.

Reported cases,	21,470	15,060	176,075
Deaths,	331	157	2,472
Fatality (per cent.),	1.5	1.0	1.4

In the foregoing tables the statistics relating to diphtheria have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. For the latter period the figures for 1908 and 1909 are given and the total for the fifteen years 1895 to 1909, inclusive. The mean fatality in the former period (1891–1894) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1909) it was 11.3 per cent., or less than half as large.

III.

Official Returns of Notified Diseases Dangerous to the Public Health for the Year ended Nov. 30, 1909, and for the Month of December, 1909.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year ended Nov. 30, 1909, under the provisions of chapter 75 of the Revised Laws. In this act no disease is specified as being "dangerous to the public health" except smallpox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: actinomycosis, anterior poliomyelitis, Asiatic cholera, cerebro-spinal meningitis, diphtheria, glanders, leprosy, malignant pustule, measles, ophthalmia neonatorum, scarlet fever, smallpox, tetanus, trachoma, trichinosis, tuberculosis, typhoid fever, typhus fever, varicella, whooping cough, yellow fever.

The whole number of cases of infective diseases reported to the Board in the year ended Nov. 30, 1909, under the provisions of this act, was 45,205, which was divided chiefly as follows: —

Reported cases of smallpox,	14
Reported cases of scarlet fever,	7,367
Reported cases of diphtheria,	7,920
Reported cases of typhoid fever,	2,750
Reported cases of measles,	14,831
Reported cases of cerebro-spinal meningitis,	140
Total,	33,022

The summary for the sixteen years and three months 1893–1909 is as follows: —

	Reported Cases of —						
	Small-pox.	Scarlet Fever.	Diph-theria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Totals.
1893 (four months only),	35	2,914	1,109	1,525	1,503	–	7,086
1894, ...	181	6,731	4,178	2,372	2,133	–	15,595
1895, ...	1	6,194	7,806	2,438	4,868	–	21,307
1896, ...	5	3,801	8,515	2,637	6,362	–	21,320
1897, ...	18	5,495	7,613	2,104	12,695	–	27,925
1898, ...	10	3,667	3,980	2,196	4,478	–	14,331
1899, ...	105	5,349	7,134	2,776	12,355	–	27,719
1900, ...	104	6,396	12,641	2,967	10,507	–	32,615
1901, ...	773	4,356	9,793	2,689	9,398	–	27,009
1902, ...	2,314	4,613	7,036	2,721	17,249	–	33,933
1903, ...	422	5,877	6,888	2,955	9,430	–	25,572
1904, ...	100	4,100	6,772	2,605	12,511	–	26,088
1905 (11 months), . .	44	3,594	5,059	2,794	6,107	455	18,053
1906 (Dec. 1, 1905–Nov. 30, 1906).	35	5,162	7,967	3,093	17,048	291	33,596
1907, ...	164	7,860	9,098	2,350	5,688	428	25,588
1908, ...	16	7,833	8,939	3,639	21,745	205	42,377
1909, ...	14	7,367	7,920	2,750	14,831	140	33,022
Totals, ...	4,341	91,309	122,448	44,611	168,908	1,519	433,136

By months these diseases were reported as follows: —

Cases of Infective Diseases reported to the State Board of Health by Months from Dec. 1, 1908, to Nov. 30, 1909.

Months.	Smallpox.	Scarlet Fever.	Diph-theria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.
December, ...	–	812	1,093	202	797	10
January, ...	1	964	922	168	1,094	8
February, ...	2	680	589	71	1,749	5
March, ...	1	793	659	86	2,212	15
April, ...	2	670	523	84	2,186	21
May, ...	1	639	514	119	2,089	13
June, ...	–	555	510	148	2,196	6
July, ...	2	348	420	157	1,089	17
August, ...	–	308	387	291	217	15
September, ...	1	427	518	543	111	14
October, ...	3	582	857	578	368	5
November, ...	1	589	928	303	723	11
Totals, ...	14	7,367	7,920	2,750	14,831	140

The following table is introduced for the purpose of facilitating the comparison of the seasonal prevalence of the diseases named in the table, in different years. By means of the method employed, the errors due to the difference in the length of the months are eliminated. The figures should be read as follows: for example, the mean daily number of reported cases of diphtheria throughout the year, Dec. 1, 1908, to Nov. 30, 1909, was 21.7; of scarlet fever, 20.2; of typhoid fever, 7.5; and of measles, 40.6. During the month of December the mean daily number of reported cases of these diseases was: for diphtheria, 35.3; scarlet fever, 26.2; typhoid fever, 6.5; and for measles, 25.7 (see columns marked A). Assuming a standard of 10 as a daily mean throughout the year for each disease, the ratios for December were as follows: diphtheria, 16.3; scarlet fever, 13.0; typhoid fever, 8.7; and measles, 6.3 (see columns marked B). So that for each 10 cases of diphtheria reported as a daily mean throughout the year, Dec. 1, 1908, to Nov. 30, 1909, there were 16.3 in December, 13.7 in January, 9.7 in February, etc.

From this table it appears that the maximum prevalence of diphtheria was in December and the minimum in August. January, October and November were also above the mean in intensity of prevalence.

The prevalence of scarlet fever was above the mean in December, January, February, March, April and May, and below it in the remaining months. The maximum occurred in January and the minimum in August.

Typhoid fever was below the mean in the intensity of its prevalence in the months December, January, February, March, April, May, June and July, the maximum occurring in October.

The prevalence of measles was above the mean in the months February to June, inclusive, and below it in the remaining months, the maximum occurring in April and June and the minimum in September.

Certain Infective Diseases. — Seasonal Intensity of Prevalence.

Months.	Diphtheria.			Scarlet Fever.			Typhoid Fever.			Measles.		
	1909.		1908.	1909.		1908.	1909.		1908.	1909.		1908.
	A	B	B	A	B	B	A	B	B	A	B	B
	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Cases reported in Each Month.	Decimal Ratio.	Decimal Ratio.
December,[1]	35.3	16.3	12.2	26.2	13.0	9.7	6.5	8.7	3.4	25.7	6.3	5.8
January,	29.7	13.7	9.3	31.1	15.4	11.1	5.4	7.2	2.5	35.3	8.7	11.8
February,	21.0	9.7	8.9	24.3	12.0	14.6	2.5	3.3	3.0	62.5	15.4	15.4
March,	21.3	9.8	9.7	25.6	12.7	14.7	2.8	3.7	2.1	71.3	17.6	18.8
April,	17.4	8.0	7.4	22.3	11.0	12.3	2.8	3.7	24.8	72.9	18.0	21.1
May,	16.6	7.6	9.1	20.6	10.2	12.7	3.8	5.1	10.9	67.4	16.6	22.9
June,	17.0	7.8	8.0	18.5	9.2	6.9	4.9	6.5	6.2	73.2	18.0	12.6
July,	13.5	6.2	6.0	11.2	5.5	3.5	5.1	6.8	8.3	35.1	8.6	4.3
August,	12.5	5.8	6.8	9.9	4.9	5.0	9.4	12.5	13.9	7.0	1.7	1.1
September,	17.3	8.0	9.6	14.2	7.0	6.3	18.1	24.1	20.8	3.7	0.9	0.6
October,	27.6	12.7	15.9	18.8	9.3	10.0	18.7	24.9	14.2	11.9	2.9	1.7
November,	30.9	14.2	16.7	19.6	9.7	12.8	10.1	13.5	9.6	24.1	5.9	3.8
Mean,	21.7	10.0	10.0	20.2	10.0	10.0	7.5	10.0	10.0	40.6	10.0	10.0

[1] The figures for December, in the first two columns, are for 1908; and in the third column, for 1907.

Cases of Infective Diseases reported to the State Board of Health from 312 Cities and Towns, from Nov. 30, 1908, to Nov. 30, 1909.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Abington,	1	107	14	1	11	3	–	4	–
Acton,	–	14	2	1	3	–	–	2	–
Acushnet,	2	–	4	2	–	–	–	8	6
Adams,	29	2	26	11	23	–	–	–	–
Agawam,	6	6	–	2	–	–	–	–	–
Amesbury,	17	3	4	6	4	–	–	2	–
Amherst,	3	56	17	5	2	–	–	–	–
Andover,	10	21	10	3	1	–	–	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Arlington, ...	30	16	40	11	6	–	–	2	1
Ashburnham, . . .	9	32	1	–	1	–	–	–	–
Ashby, ...	–	32	–	–	1	–	–	–	–
Ashfield, ...	–	27	–	–	–	–	–	9	–
Ashland, ...	–	–	1	–	–	–	–	–	–
Athol, ...	18	32	23	1	5	–	–	–	2
Attleborough, . . .	18	15	31	7	22	–	–	5	13
Auburn, ...	5	–	4	3	–	–	–	–	–
Avon, ...	2	161	1	3	6	–	–	95	3
Ayer, ...	18	81	2	–	–	–	–	–	1
Barnstable, . . .	2	85	5	1	–	–	–	–	12
Barre, ...	–	4	–	–	–	–	–	–	–
Becket, ...	–	10	1	–	–	–	–	–	–
Bedford, ...	1	–	2	–	–	–	–	–	–
Belchertown, . . .	4	2	1	–	–	–	–	–	–
Bellingham, . . .	1	–	2	1	–	–	–	–	–
Belmont, ...	5	5	12	–	–	–	–	1	–
Berkley, ...	–	–	–	1	–	–	–	–	–
Berlin, ...	–	2	2	1	–	–	–	–	–
Beverly, ...	13	68	29	11	10	–	–	5	4
Billerica, ...	10	–	–	–	–	–	–	1	–
Blackstone, . . .	23	–	7	6	7	–	–	–	–
Blandford, . . .	–	–	–	1	1	–	–	–	–
Boston, ...	2,667	2,648	2,032	722	2,819	61	4	549	1,039
Bourne, ...	–	1	1	–	–	–	–	–	–
Boylston, . . .	1	–	–	–	–	–	–	–	–
Braintree, . . .	10	227	15	4	9	–	–	2	–
Brewster, . . .	–	4	4	–	–	–	–	–	–
Bridgewater, . . .	4	47	3	1	32	–	–	10	4
Brimfield, . . .	–	1	–	1	–	–	–	–	–
Brockton, . . .	36	1,740	68	92	118	–	–	141	37
Brookfield, . . .	–	–	1	–	1	–	–	–	–
Brookline, . . .	68	93	57	26	20	–	–	–	–
Buckland, . . .	1	–	–	1	–	–	1	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Burlington,	–	–	2	–	–	–	–	–	–
Cambridge,	289	566	388	80	352	6	–	105	64
Canton,	–	7	5	1	8	–	–	2	1
Carlisle,	1	1	1	–	–	–	–	4	–
Charlemont,	–	40	–	–	–	–	–	–	1
Charlton,	4	8	2	2	–	–	–	–	9
Chatham,	1	3	3	1	–	–	–	–	–
Chelmsford,	4	65	5	1	–	–	–	–	–
Chelsea,	95	55	94	24	41	–	–	12	31
Cheshire,	–	–	–	2	1	–	–	–	–
Chester,	2	12	1	–	–	–	–	–	3
Chesterfield,	–	2	–	1	1	–	–	–	–
Chicopee,	40	23	16	5	22	–	–	5	23
Chilmark,	–	–	–	1	1	–	–	–	–
Clarksburg,	1	–	–	–	–	–	–	–	–
Clinton,	20	4	1	8	1	1	–	2	–
Colrain,	2	1	3	1	2	–	–	10	–
Concord,	4	32	13	1	6	–	–	5	17
Conway,	1	1	–	–	–	–	–	–	–
Cummington,	–	1	–	–	–	–	–	–	–
Dalton,	–	–	7	–	–	1	–	–	–
Dana,	–	21	2	–	–	–	–	–	–
Danvers,	12	54	26	7	19	2	–	17	–
Dartmouth,	3	5	7	–	–	–	–	–	–
Dedham,	15	23	20	6	10	–	–	1	3
Deerfield,	5	10	1	–	–	1	–	–	–
Dennis,	–	1	–	–	1	–	–	–	–
Dighton,	1	11	4	1	–	–	–	–	–
Douglas,	1	–	1	4	1	–	–	–	1
Dudley,	–	1	–	2	–	–	–	–	–
Dunstable,	–	–	–	–	1	–	–	–	–
Duxbury,	3	4	5	1	–	–	–	–	–
East Bridgewater,	4	118	5	–	76	–	–	7	6
East Longmeadow,	2	–	1	–	–	–	–	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Eastham,	–	–	2	–	–	–	–	1	–
Easthampton,	15	–	3	6	–	–	–	–	–
Easton,	5	8	7	–	4	–	–	10	–
Edgartown,	–	–	6	–	–	–	–	–	–
Egremont,	–	–	1	1	–	–	–	–	–
Erving,	–	–	3	–	–	–	–	–	–
Essex,	8	–	1	2	1	–	–	6	–
Everett,	58	53	150	24	53	2	–	7	40
Fairhaven,	4	4	6	5	–	–	–	–	1
Fall River,	110	72	185	137	233	–	–	31	17
Falmouth,	2	44	2	2	3	–	–	2	9
Fitchburg,	75	696	88	26	86	1	1	4	1
Foxborough,	–	4	2	2	–	–	–	–	–
Framingham,	9	86	21	10	7	1	–	10	1
Franklin,	3	3	26	1	2	–	–	–	–
Freetown,	–	2	5	1	–	–	–	5	3
Gardner,	32	96	20	10	48	–	–	2	54
Georgetown,	–	1	6	1	–	–	–	–	–
Gill,	1	–	1	–	–	–	–	–	–
Gloucester,	33	125	17	12	28	–	–	85	5
Grafton,	10	–	3	–	–	–	–	–	–
Great Barrington,	1	422	27	6	3	–	–	–	1
Greenfield,	5	1	8	4	–	2	–	–	–
Greenwich,	–	1	1	–	–	–	–	–	–
Groveland,	2	71	2	1	1	–	–	–	–
Hadley,	–	7	10	–	1	–	–	–	1
Halifax,	–	2	–	2	–	–	–	–	–
Hampden,	1	–	–	–	–	–	–	–	–
Hanover,	1	–	3	–	–	–	–	–	–
Hanson,	–	13	–	–	3	–	–	–	–
Hardwick,	–	1	7	2	1	–	–	–	–
Harvard,	1	–	–	1	–	–	–	–	–
Harwich,	3	3	5	3	1	–	–	–	–
Hatfield,	5	64	6	–	1	–	–	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Haverhill,	247	130	65	55	119	2	–	54	72
Heath,	–	2	–	–	–	–	–	–	–
Hingham,	5	3	2	1	–	–	–	–	–
Hinsdale,	–	–	6	–	–	–	–	–	–
Holbrook,	1	34	1	2	2	–	–	12	3
Holden,	–	1	6	10	2	–	–	8	3
Holliston,	–	1	3	–	–	–	–	–	–
Holyoke,	141	181	45	17	44	2	–	7	2
Hopedale,	–	–	5	1	1	–	–	–	–
Hopkinton,	2	1	6	–	2	–	–	–	–
Hubbardston,	1	1	8	1	–	–	–	–	–
Hudson,	8	112	6	2	3	–	–	–	–
Hull,	–	1	–	3	1	–	–	–	–
Huntington,	5	–	–	1	–	–	–	–	–
Hyde Park,	18	14	37	11	16	3	–	4	12
Ipswich,	2	13	11	3	2	–	–	2	–
Kingston,	8	3	7	3	–	–	–	–	1
Lakeville,	–	–	2	–	–	–	–	–	–
Lancaster,	17	3	3	1	8	–	–	2	1
Lanesborough,	–	–	1	–	–	–	–	–	–
Lawrence,	184	766	88	86	113	2	2	14	54
Lee,	–	–	7	3	2	–	–	–	–
Leicester,	4	2	2	–	–	–	–	–	–
Lenox,	1	–	7	–	–	–	–	–	–
Leominster,	77	426	16	13	19	1	–	102	11
Leverett,	1	–	–	–	–	–	–	–	–
Lexington,	5	6	33	–	4	–	–	21	9
Littleton,	3	4	–	–	–	–	–	–	–
Lowell,	218	197	93	93	156	6	–	12	15
Ludlow,	13	–	27	–	–	–	–	–	–
Lunenburg,	–	13	–	–	–	–	–	–	–
Lynn,	332	85	162	43	97	3	–	28	15
Lynnfield,	2	26	4	–	1	–	–	–	–
Malden,	142	144	181	33	74	1	–	11	10

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Manchester, . . .	3	1	–	–	1	–	–	–	1
Mansfield, . . .	32	5	5	–	5	–	–	10	2
Marblehead, . . .	6	4	14	12	4	–	–	3	2
Marion, ...	1	1	2	–	–	–	–	–	–
Marlborough, . . .	27	17	11	9	15	–	–	3	2
Marshfield, . . .	–	21	–	–	2	–	–	–	–
Mattapoisett, . . .	–	2	7	–	–	–	–	–	–
Medfield, ...	4	143	6	–	5	–	–	6	9
Medford, ...	66	118	41	8	28	1	–	–	2
Medway, ...	2	31	9	–	1	–	–	–	–
Melrose, ...	23	22	108	12	30	–	–	79	9
Mendon, ...	–	–	–	–	1	–	–	–	–
Merrimac, . . .	15	–	–	1	–	–	–	–	–
Methuen, . . .	29	70	24	6	10	1	–	–	22
Middleborough, . .	4	4	17	1	2	1	–	–	–
Middleton, . . .	5	1	–	–	–	–	–	–	–
Milford, ...	11	1	23	3	6	–	–	–	–
Millbury, ...	10	1	4	2	1	–	–	–	–
Millis, ...	3	1	–	–	1	–	–	–	–
Milton, ...	13	56	18	5	16	–	–	10	32
Monroe, ...	–	–	5	–	–	–	–	–	–
Monson, ...	8	1	2	7	–	–	–	2	2
Montague, . . .	–	–	1	–	–	–	–	–	–
Mount Washington, .	–	6	–	–	1	–	–	–	–
Nahant, ...	3	–	5	2	–	–	–	–	–
Nantucket, . . .	–	–	21	–	1	–	–	–	–
Natick, ...	3	–	38	2	1	–	–	–	–
Needham, . . .	3	2	1	1	–	–	–	–	–
New Bedford, . . .	80	171	289	126	190	6	3	63	38
New Braintree, . .	–	–	–	–	1	–	–	–	–
New Marlborough, . .	–	1	–	–	–	–	–	–	–
New Salem, . . .	–	22	–	–	1	–	–	–	–
Newbury, . . .	2	1	3	2	–	–	–	–	–
Newburyport, . . .	24	1	5	29	42	1	–	1	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Newton,	123	320	132	20	60	3	–	4	39
North Adams,	13	11	25	32	28	1	–	6	3
North Andover,	9	37	6	2	3	–	–	–	1
North Attleborough,	1	29	14	–	7	1	–	66	–
North Brookfield,	1	4	3	–	–	–	–	–	–
North Reading,	–	21	10	–	4	–	–	–	–
Northampton,	22	367	15	20	20	2	–	14	12
Northborough,	8	1	–	1	–	–	–	–	–
Northbridge,	13	4	26	1	–	–	–	–	–
Northfield,	1	1	3	1	–	–	2	–	–
Norton,	–	6	1	–	1	–	–	–	–
Norwell,	6	–	1	1	2	–	–	5	–
Norwood,	18	45	2	17	14	–	–	2	4
Oak Bluffs,	–	4	2	–	3	–	–	–	2
Oakham,	–	–	–	–	–	–	–	–	1
Orange,	1	6	43	–	–	–	–	–	–
Oxford,	3	2	10	18	–	–	–	2	–
Palmer,	32	28	20	7	–	–	–	–	–
Peabody,	17	7	31	10	7	–	–	5	1
Pelham,	–	1	1	–	–	–	–	–	–
Pembroke,	1	6	6	1	–	–	–	–	–
Pepperell,	5	3	5	–	1	–	–	–	–
Petersham,	–	4	–	–	1	–	–	–	–
Phillipston,	–	–	1	–	4	–	–	–	–
Pittsfield,	32	18	52	42	71	1	–	3	21
Plainville,	–	2	1	–	1	–	–	–	–
Plymouth,	22	4	10	6	17	–	–	–	1
Plympton,	–	3	3	–	–	–	–	–	–
Princeton,	1	2	1	–	–	–	–	–	–
Provincetown,	9	3	–	6	11	–	–	13	–
Quincy,	91	70	43	19	30	1	–	16	2
Randolph,	4	–	1	–	–	–	–	–	–
Raynham,	–	–	1	–	–	–	–	–	–
Reading,	1	31	–	1	–	–	–	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Rehoboth, . . .	–	8	1	–	1	–	–	–	–
Revere, ...	36	–	69	4	1	–	–	–	–
Richmond, . . .	–	1	–	–	–	–	–	–	–
Rochester, . . .	–	1	1	2	–	–	–	–	–
Rockland, . . .	–	18	7	5	31	1	–	1	2
Rockport, . . .	8	6	4	1	11	1	–	30	6
Rowe, ...	–	–	–	–	–	–	–	3	–
Rowley, ...	–	38	–	1	–	–	–	–	1
Royalston, . . .	1	5	–	–	–	–	–	–	–
Russell, ...	–	–	–	1	–	–	–	–	–
Rutland, ...	–	–	–	–	1,012	–	–	–	–
Salem, ...	61	41	114	35	123	–	–	32	24
Salisbury, . . .	–	–	7	1	–	–	–	–	–
Sandwich, . . .	2	1	–	–	–	–	–	–	–
Saugus, ...	5	13	25	8	6	–	–	–	4
Savoy, ...	–	9	1	–	–	–	–	–	5
Scituate, ...	4	1	2	1	–	–	–	–	–
Seekonk, ...	1	–	3	–	–	–	–	–	–
Sharon, ...	1	79	5	–	7	–	–	28	–
Sheffield, ...	–	25	2	–	1	–	–	3	13
Shelburne, . . .	1	–	–	–	–	–	–	–	–
Sherborn, . . .	–	22	2	–	–	–	–	3	–
Shirley, ...	9	–	–	1	–	–	–	–	–
Shrewsbury, . . .	2	–	–	1	–	–	–	–	–
Somerset, . . .	1	–	9	3	–	–	–	–	–
Somerville, . . .	390	388	332	96	160	4	1	8	20
South Hadley, . . .	4	36	–	–	–	–	–	–	1
Southampton, . . .	3	–	–	–	–	–	–	–	–
Southborough, . .	6	1	–	–	–	–	–	1	–
Southbridge, . . .	37	34	49	17	3	–	–	–	–
Southwick, . . .	–	7	–	1	–	–	–	32	–
Spencer, ...	10	2	2	1	–	–	–	1	–
Springfield, . . .	344	321	140	57	104	1	–	54	146
Sterling, ...	13	57	1	–	2	–	–	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Stockbridge, . . .	5	3	8	1	–	–	–	–	–
Stoneham, . . .	20	2	12	3	4	–	–	–	–
Stoughton, . . .	27	166	28	4	4	–	–	18	1
Sturbridge, . . .	–	–	–	1	1	–	–	–	–
Sudbury, ...	–	1	–	–	–	–	–	–	–
Sunderland, . . .	3	2	–	–	–	–	–	–	–
Sutton, ...	5	–	1	8	3	–	–	–	–
Swampscott, . . .	9	2	8	4	5	1	–	1	1
Swansea, ...	–	2	3	2	–	–	–	2	–
Taunton, ...	14	92	58	37	46	–	–	35	9
Templeton, . . .	10	1	1	8	1	–	–	–	7
Tewksbury, . . .	2	1	–	–	7	–	–	1	–
Tisbury, ...	–	4	3	–	–	–	–	–	–
Tolland, ...	–	–	1	–	–	–	–	–	–
Topsfield, . . .	4	–	1	–	–	–	–	1	1
Townsend, . . .	6	8	–	1	–	–	–	–	2
Tyngsborough, . .	1	3	2	–	1	–	–	1	–
Tyringham, . . .	–	–	3	–	–	–	–	–	–
Upton, ...	–	–	12	2	2	–	–	–	7
Uxbridge, . . .	12	–	2	1	2	–	–	–	–
Wakefield, . . .	15	95	12	7	5	–	–	1	2
Walpole, ...	4	2	13	1	4	–	–	5	–
Waltham, . . .	125	305	166	56	43	–	–	16	10
Ware, ...	5	1	4	5	15	2	–	–	–
Wareham, . . .	2	23	2	–	6	–	–	1	6
Warren, ...	14	–	1	4	–	–	–	–	–
Warwick, ...	–	–	1	–	–	–	–	–	–
Washington, . . .	–	–	3	–	1	–	–	1	–
Watertown, . . .	16	20	45	3	11	1	–	1	4
Wayland, ...	1	6	4	2	–	–	–	–	–
Webster, ...	2	3	4	–	4	–	–	–	–
Wellesley, . . .	4	16	21	2	9	–	–	–	8
Wellfleet, ...	–	–	3	–	–	–	–	–	–
Wenham, ...	–	1	–	–	–	–	–	–	–

Cases of Infective Diseases, etc. — Concluded.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
West Boylston, . .	1	16	1	–	–	–	–	–	–
West Bridgewater, . .	–	–	1	6	–	–	–	–	–
West Brookfield, . .	6	–	–	3	1	–	–	–	–
West Newbury, . .	3	–	4	–	–	–	–	–	–
West Springfield, . .	16	6	8	2	–	–	–	–	6
West Stockbridge, . .	1	–	–	–	–	–	–	–	–
West Tisbury, . . .	–	1	–	–	1	–	–	–	–
Westborough, . . .	5	4	5	4	–	–	–	–	1
Westfield, . . .	16	124	22	14	22	1	–	10	5
Westford, . . .	11	–	1	1	1	–	–	–	–
Westhampton, . . .	1	17	–	–	–	–	–	–	–
Westminster, . . .	2	33	–	–	1	–	–	–	–
Weston, ...	–	25	9	–	5	–	–	–	–
Westport, . . .	2	6	3	1	4	1	–	–	–
Westwood, . . .	1	–	–	2	–	–	–	–	–
Weymouth, . . .	21	26	15	2	13	–	–	–	–
Whately, ...	–	–	4	–	–	–	–	–	–
Whitman, . . .	6	98	15	–	13	1	–	3	9
Wilbraham, . . .	4	3	18	1	–	–	–	–	–
Williamsburg, . . .	3	82	24	–	3	1	–	2	6
Williamstown, . . .	5	–	11	2	3	–	–	–	2
Wilmington, . . .	1	–	2	–	1	–	–	–	–
Winchendon, . . .	7	5	13	3	6	1	–	7	20
Winchester, . . .	5	12	68	5	13	–	–	3	8
Windsor, ...	–	2	–	–	–	–	–	–	–
Winthrop, . . .	3	62	20	1	4	–	–	–	8
Woburn, ...	36	5	22	4	29	1	–	1	–
Worcester, . . .	360	124	282	163	289	3	–	96	26
Worthington, . . .	–	1	–	–	–	–	–	–	–
Wrentham, . . .	3	–	–	–	–	–	–	–	–
Yarmouth, . . .	–	3	–	–	–	–	–	–	–
Total, . . .	7,920	14,831	7,367	2,750	7,482	140	14	2,161	2,201

Actinomycosis occurred in the following place:—

Cambridge,	1

Anterior poliomyelitis occurred in the following places:—

Adams,	1
Braintree,	1
Gloucester,	1
Lee,	1
Lowell,	1
Medford,	1
Milton,	2
North Adams,	3
Pembroke,	1
Quincy,	1
	13

Anthrax occurred in the following places:—

Haverhill,	1
Lynn,	3
Norwood,	1
	5

Erysipelas occurred in the following places:—

Chelsea,	2
Hardwick,	1
Lynn,	2
Marlborough,	1
North Adams,	2
Rehoboth,	1
Salem,	11
Somerville,	2
	22

Leprosy occurred in the following places:—

Boston,	2
Haverhill,	1
Upton,	1
	4

Malignant pustule occurred in the following places:—

Haverhill,	1
Sheffield,	1
	2

Mumps occurred in the following places:—

Barre,	6
Chelsea,	2
Concord,	2
Everett,	7
Fall River,	5
Hyde Park,	9
Mansfield,	1
Melrose,	1
North Adams,	1
Norwood,	3
Oak Bluffs,	2
Oxford,	1
Provincetown,	7
Quincy,	1
Salem,	1
Somerville,	1
Springfield,	1
Sterling,	1
West Boylston,	42
Winchendon,	2
Winthrop,	1
	97

Ophthalmia neonatorum occurred in the following places:—

Abington,	1
Ashburnham,	1
Braintree,	1
Brockton,	3
Brookline,	2
Cambridge,	6
Chesterfield,	1
Concord,	2
Enfield,	1
Fitchburg,	2
Freetown,	1
Gardner,	3
Hatfield,	1
Haverhill,	6
Holyoke,	1

Hull,	1
Lowell,	9
Lynn,	6
Malden,	3
Marlborough,	2
Melrose,	2
Middleborough,	1
Milford,	1
New Bedford,	2
Newburyport,	4
North Adams,	1
North Attleborough,	1
Northampton,	2
Peabody,	1
Pittsfield,	2
Plymouth,	1
Quincy,	1
Somerville,	4
Springfield,	5
Upton,	1
Watertown,	2
Westfield,	4
Weston,	1
Wilmington,	1
Winchendon,	1
Worcester,	10
	101

Scabies occurred in the following place: —

Waltham,	1

Tetanus occurred in the following places: —

Brockton,	1
Fitchburg,	2
Gardner,	1
Gloucester,	2
Hadley,	1
Haverhill,	1
Lawrence,	2
Marlborough,	1
Melrose,	1
New Bedford,	1
Springfield,	1
Worcester,	2
	16

Trachoma occurred in the following places:—

Lawrence,	3
Lowell,	1
Worcester,	1
	5

Trichinosis occurred in the following places:—

Cambridge,	2
Dedham,	1
Northampton,	2
	5

Tubercular meningitis occurred in the following places:—

Brockton,	1
Dedham,	2
Haverhill,	1
Hudson,	1
Lancaster,	1
Lunenburg,	1
Lynn,	1
Methuen,	1
Newton,	1
Palmer,	1
Pittsfield,	1
Waltham,	1
Worcester,	1
	14

Tuberculosis other than phthisis occurred in the following places:—

Cambridge,	6
Canton,	1
Easton,	2
Fall River,	2
Gloucester,	1
Haverhill,	1
Hyde Park,	1
Kingston,	1
Lancaster,	1
Lowell,	1
New Bedford,	3
Northampton,	1
Provincetown,	2
Salem,	2
Walpole,	1
Weston,	2
Worcester,	16
	44

Meningitis other than cerebro-spinal occurred in the following places: —

Abington,	1
Cambridge,	1
East Bridgewater,	1
Malden,	1
Melrose,	1
Watertown,	1
Winchendon,	1
	7

Malaria occurred in the following place: —

Brookline,	1

Impetigo contagiosa occurred in the following place: —

Fall River,	1

List of Cities and Towns from which no Reports were received.

I. Cities.

None.

II. Towns having a Population of More than 5,000.

Maynard, — 1.

III. Towns having a Population of More than 1,000 but Less than 5,000 in Each.

Carver,	Groton,	Norfolk,
Cohasset,	Hamilton,	Orleans,
Dracut,	Lincoln,	Stow. — 9.

IV. Towns having Less than 1,000 Inhabitants.

Alford,	Granville,	Otis,
Bernardston,	Hancock,	Paxton,
Bolton,	Hawley,	Peru,
Boxborough,	Holland,	Plainfield,
Boxford,	Leyden,	Prescott,
Dover,	Longmeadow,	Sandisfield,
Florida,	Mashpee,	Shutesbury,
Gay Head,	Middlefield,	Truro,
Goshen,	Monterey,	Wales,
Gosnold,	Montgomery,	Wendell. — 32.
Granby,	New Ashford,	

Official Returns of Notified Diseases Dangerous to the Public Health for the Month of December, 1909.

The whole number of cases of infective diseases reported to the Board for the month of December, 1909, was 3,787, which was divided chiefly as follows: —

Reported cases of smallpox,	7
Reported cases of scarlet fever,	669
Reported cases of diphtheria,	875
Reported cases of typhoid fever,	195
Reported cases of measles,	1,026
Reported cases of cerebro-spinal meningitis,	3
Total,	2,775

The summary for the sixteen years and four months, 1893–1909, is as follows: —

	Reported Cases of —						
	Smallpox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Cerebro-spinal Meningitis.	Totals.
Totals, sixteen years, three months,	4,341	91,309	122,448	44,611	168,908	1,519	433,136
Month of December, 1909,	7	669	875	195	1,026	3	2,775
Totals,	4,348	91,978	123,323	44,806	169,934	1,522	435,911

Cases of Infective Diseases reported to the State Board of Health from 314 Cities and Towns, for the Month of December, 1909.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Acushnet,	–	–	1	–	–	–	–	–	–
Adams,	5	–	1	–	1	–	–	–	–
Agawam,	1	–	–	–	–	–	–	–	–
Amesbury,	1	–	–	1	1	–	–	–	–
Amherst,	–	–	2	8	–	–	–	4	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Andover,	–	27	2	1	–	–	–	–	–
Arlington,	–	1	3	–	3	–	–	–	–
Ashburnham,	–	–	1	–	–	–	–	–	–
Ashby,	–	11	–	–	–	–	–	–	–
Athol,	1	–	3	–	–	–	–	–	1
Attleborough,	4	1	–	1	5	–	–	–	–
Avon,	–	–	–	–	–	–	–	–	15
Ayer,	6	–	–	–	–	–	–	–	–
Barre,	1	–	–	–	–	–	–	–	–
Bedford,	–	2	1	–	–	–	–	–	–
Belchertown,	–	12	–	–	–	–	–	–	–
Belmont,	2	–	–	–	–	–	–	–	–
Beverly,	3	–	2	1	1	–	–	–	2
Blackstone,	1	–	–	–	–	–	–	–	–
Boston,	306	284	165	41	246	1	–	24	101
Boylston,	–	–	2	–	–	–	–	–	–
Braintree,	–	–	2	–	–	–	–	–	–
Brockton,	3	1	8	11	6	–	–	–	20
Brookline,	6	3	2	2	4	–	–	–	–
Buckland,	3	–	–	–	–	–	–	–	–
Cambridge,	37	24	22	4	17	–	–	11	5
Canton,	1	–	–	–	1	–	–	–	–
Carver,	2	–	–	–	–	–	–	–	–
Chelmsford,	–	4	–	–	–	–	–	–	–
Chelsea,	9	13	15	2	3	–	–	–	2
Chesterfield,	–	–	–	–	–	–	–	–	6
Chicopee,	5	2	3	1	5	–	–	–	–
Clinton,	2	1	–	–	3	–	–	–	–
Concord,	–	1	2	–	3	–	–	–	6
Dana,	–	–	1	–	–	–	–	–	–
Danvers,	2	–	–	2	1	–	–	–	–
Dartmouth,	–	2	–	–	–	–	–	–	–
Dedham,	1	–	1	–	2	–	–	–	–
Deerfield,	–	–	–	2	–	–	–	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Dighton,	-	-	2	-	-	-	-	-	-
Douglas,	-	-	-	-	-	-	-	-	5
Dracut,	-	1	-	-	-	-	-	-	-
East Bridgewater,	-	-	-	-	9	-	-	-	-
East Longmeadow,	-	-	1	-	-	-	-	-	-
Easthampton,	7	-	1	2	-	-	-	-	1
Egremont,	-	-	3	-	-	-	-	-	-
Erving,	1	3	1	-	-	-	-	-	-
Essex,	1	-	-	-	-	-	-	-	-
Everett,	4	-	7	1	1	-	-	-	1
Fall River,	7	1	19	13	20	-	-	2	2
Fitchburg,	16	80	2	3	4	-	-	-	-
Foxborough,	-	-	2	-	-	-	-	-	-
Gardner,	1	-	7	1	5	-	-	-	7
Georgetown,	-	21	-	-	-	-	-	-	-
Gloucester,	2	3	-	-	-	-	-	-	-
Grafton,	2	-	5	-	-	-	-	-	-
Great Barrington,	-	-	-	1	1	-	-	1	8
Greenfield,	-	1	8	-	-	-	-	-	-
Groveland,	-	32	-	-	-	-	-	-	-
Hadley,	-	-	-	-	1	-	-	-	-
Hampden,	-	-	3	-	-	-	-	-	-
Hardwick,	-	-	-	1	-	-	-	-	-
Harvard,	5	-	-	-	-	-	-	-	-
Harwich,	1	-	-	-	-	-	-	-	-
Hatfield,	2	-	2	-	-	-	-	-	-
Haverhill,	20	18	15	5	9	-	-	18	3
Holbrook,	1	-	-	-	1	-	-	-	-
Holyoke,	10	62	2	4	2	-	-	3	-
Hopkinton,	-	-	1	-	-	-	-	-	-
Hudson,	-	-	1	-	1	-	-	-	1
Hyde Park,	4	2	10	-	3	-	-	-	1
Ipswich,	5	1	1	-	1	-	-	-	-
Kingston,	-	1	-	-	-	-	-	-	-

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Lancaster,	–	–	3	1	–	–	–	–	–
Lawrence,	13	43	18	4	15	–	–	1	3
Lee,	–	–	3	–	–	–	–	1	–
Leominster,	16	2	2	–	–	–	–	–	7
Leverett,	–	–	–	2	–	–	–	–	–
Lexington,	–	2	1	–	–	–	–	–	–
Lowell,	19	125	8	13	15	–	–	–	1
Ludlow,	3	1	1	–	–	–	–	–	–
Lunenburg,	–	2	–	–	–	–	–	–	–
Lynn,	59	4	21	5	9	–	–	–	2
Malden,	5	1	20	–	6	–	–	–	2
Mansfield,	1	–	–	–	–	–	–	–	4
Marblehead,	1	1	7	2	–	–	–	–	–
Marlborough,	3	–	1	–	1	–	–	–	–
Medfield,	–	1	–	–	–	–	–	–	–
Medford,	8	–	2	–	2	–	–	–	–
Melrose,	1	2	5	1	6	–	–	–	2
Merrimac,	1	–	–	–	–	–	–	–	–
Methuen,	–	–	2	–	–	–	–	–	–
Middleborough,	–	–	–	–	1	–	–	–	–
Milford,	2	–	2	1	–	–	–	–	–
Milton,	1	11	11	–	–	–	–	–	7
Monson,	–	–	–	1	–	–	–	–	–
Nantucket,	–	–	21	–	–	–	–	–	–
Natick,	–	–	2	–	–	–	–	–	–
Needham,	–	–	1	–	1	–	–	–	–
New Bedford,	7	36	35	7	17	–	–	2	2
Newburyport,	3	–	–	–	1	–	–	–	1
Newton,	12	1	12	–	6	–	–	–	3
North Adams,	–	–	1	–	6	–	–	–	–
North Andover,	2	2	1	–	1	–	–	–	–
North Attleborough,	–	–	1	–	1	–	–	1	–
Northampton,	2	1	2	–	2	–	–	–	5
Northborough,	1	1	2	–	–	–	–	–	–

Cases of Infective Diseases, etc. — Continued.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Smallpox.	Whooping Cough.	Varicella.
Northbridge, . . .	–	–	7	–	–	–	–	–	–
Norwell, ...	–	–	–	3	–	–	–	–	–
Norwood, . . .	6	1	1	3	1	–	–	–	1
Oxford, ...	–	–	3	–	–	–	–	–	–
Palmer, ...	4	8	–	–	–	–	–	1	–
Peabody, ...	3	–	–	1	1	–	–	–	–
Pembroke, . . .	1	–	–	–	–	–	–	–	–
Pittsfield, . . .	12	2	1	4	1	–	–	–	–
Plainville, . . .	–	1	–	–	–	–	–	–	–
Plymouth, . . .	12	–	–	–	–	–	–	–	–
Provincetown, . . .	3	–	–	–	3	–	–	–	–
Quincy, ...	2	40	5	1	5	–	–	–	1
Rehoboth, . . .	–	–	1	–	–	–	–	–	–
Revere, ...	2	–	4	–	–	–	–	–	–
Rockland, . . .	–	2	–	1	1	–	–	–	–
Rockport, . . .	–	–	–	–	–	–	–	–	2
Rutland, ...	–	–	–	–	82	–	–	–	–
Salem, ...	2	1	9	–	4	–	–	–	2
Salisbury, . . .	–	–	–	–	1	–	–	–	–
Saugus, ...	3	–	2	–	–	–	–	–	–
Scituate, ...	1	–	–	–	–	–	–	–	–
Somerville, . . .	21	3	33	8	9	2	–	–	4
South Hadley, . .	–	–	1	–	–	–	–	–	–
Southampton, . . .	1	–	–	–	–	–	–	–	–
Southbridge, . . .	2	43	4	2	–	–	–	–	1
Spencer, ...	–	–	3	–	–	–	–	–	–
Springfield, . . .	33	9	15	4	3	–	–	1	2
Sterling, ...	–	–	–	1	–	–	–	–	–
Stoneham, . . .	2	3	–	–	–	–	–	–	–
Stoughton, . . .	4	–	–	1	2	–	–	2	2
Sturbridge, . . .	–	2	–	–	–	–	–	–	–
Sudbury, ...	–	1	–	–	–	–	–	–	–
Sutton, ...	–	–	1	2	–	–	–	–	–
Swampscott, . . .	1	–	2	–	–	–	–	–	5

Cases of Infective Diseases, etc. — Concluded.

	Diphtheria.	Measles.	Scarlet Fever.	Typhoid Fever.	Tuberculosis.	Cerebro-spinal Meningitis.	Small-pox.	Whooping Cough.	Varicella.
Taunton,	3	8	4	3	2	-	-	-	3
Topsfield,	-	-	-	1	-	-	-	-	-
Townsend,	-	1	-	-	-	-	-	-	-
Uxbridge,	-	-	3	-	-	-	-	-	-
Wakefield,	2	-	-	-	-	-	-	-	-
Waltham,	20	-	4	4	3	-	-	-	15
Ware,	6	28	-	-	1	-	-	-	-
Wareham,	-	-	-	-	1	-	-	-	-
Warren,	-	-	1	-	-	-	-	2	-
Watertown,	8	3	1	1	2	-	-	-	-
Wayland,	-	-	1	-	-	-	-	-	-
Webster,	-	1	-	-	3	-	-	-	-
Wellesley,	3	-	5	-	1	-	-	-	1
West Springfield,	3	-	2	-	-	-	-	-	-
Westfield,	3	1	2	1	3	-	-	-	-
Westford,	-	-	-	-	1	-	-	-	1
Westminster,	-	-	-	1	-	-	-	-	-
Westport,	-	1	-	-	-	-	-	-	-
Weymouth,	6	-	3	1	-	-	-	-	1
Whately,	-	-	-	1	-	-	-	-	-
Whitman,	-	-	7	-	1	-	-	-	1
Wilbraham,	-	-	3	2	-	-	-	-	-
Williamsburg,	-	-	4	-	-	-	-	-	-
Winchendon,	-	-	-	1	-	-	7	-	-
Winchester,	-	-	1	-	-	-	-	-	3
Winthrop,	3	5	3	-	-	-	-	-	13
Woburn,	8	-	1	2	1	-	-	-	-
Worcester,	45	11	15	7	31	-	-	7	3
Totals,	875	1,026	669	195	613	3	7	81	287

Anterior poliomyelitis occurred in the following places: —

Adams,	1
Arlington,	1
Fall River,	1
Hudson,	1
Malden,	2
Winthrop,	1
Worcester,	1
	8

Erysipelas occurred in the following places: —

Palmer,	1
Somerville,	1
	2

Leprosy occurred in the following place: —

New Bedford,	1

Mumps occurred in the following places: —

Everett,	5
Fall River,	1
Somerville,	1
	7

Ophthalmia neonatorum occurred in the following places: —

Brockton,	1
Malden,	2
Quincy,	1
	4

Tetanus occurred in the following place: —

Boston,	1

Trachoma occurred in the following place: —

Haverhill,	3

Trichinosis occurred in the following place: —

Webster,	1

Tuberculosis other than phthisis occurred in the following places: —

New Bedford,	1
Salem,	1
Worcester,	2
	4

A supply of postal cards for the purpose of reporting infectious diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the secretary of the State Board, Room 145, State House, Boston.

IV.

Official Returns of Deaths in Cities and Large Towns (Revised Laws, Chapter 75, Section 12).

1908.

In the following summary, the statistics of deaths required by chapter 75, section 12, of the Revised Laws, are presented. These statistics are returned to the Board from each city and town which has, "according to the latest census, more than five thousand inhabitants."

The cities and towns which have contributed these returns for the year 1908 comprise the same list as that of 1907. This list embraces all of the 33 cities and the towns having more than 5,000 inhabitants in each.

Hingham and Williamstown have again made returns, although their populations fell below 5,000 in 1905.

The list for the year 1908 includes 100 cities and towns. The total estimated population of this group of cities and towns in 1908, based upon the rate of growth between the two census years 1900 and 1905, was 2,715,592, or about 87 per cent. of the estimated total population of the State.

The whole number of registered deaths in these cities and towns in 1908 was 44,537, and the death-rate, as calculated from the foregoing estimated population, was 16.40 per 1,000 of the living population, that of the previous year having been 17.46 per 1,000, and that of 1906, 16.61 per 1,000.

The death-rate for the year 1908 was lower than that of 1907, and considerably lower than the mean annual death-rate of the State for the fifty years ended Dec. 31, 1900, which was 19.22 per 1,000.

Sexes. — The number of deaths of males was 23,080, or 51.83 per cent. of the whole number of deaths whose sex was known; and the

deaths of females were 21,451, or 48.17 per cent. There were 6 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows: —

Ages.	Deaths, 1908.	Percentages of All Deaths.	
		1908.	1907.
Under 1 year,	10,202	22.92	21.55
1 to 20 years,	6,508	14.62	13.32
20 to 50 years,	9,909	22.26	24.34
50 and over,	17,894	40.20	40.79

Infant Mortality. — The deaths of infants under one year old were 10,202, or 22.92 per cent. of the total mortality, as compared with 21.55 per cent. in 1907. In the year 1900 the rate was 23; that of the five years 1904–08, respectively, constituted 21.34, 21.27, 22.06, 21.55 and 22.92 per cent. of the total mortality.

The deaths of children under five years old were 14,066, or 31.6 per cent. of the total mortality, as compared with 28.7 per cent. for the same age in 1907.

All of the percentages in the foregoing table were estimated upon the number of deaths of those whose ages were stated in the returns. The total number of deaths in which the age was not specified was 24; in 1907 it was 28.

Still-births. — The number of still-births was 3,024, and when compared with the total mortality (still-births included), this was 6.4 per cent. of the total deaths and still-births combined. In 1907 the percentage was 6.3.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths, 1908.	Percentages.	
		1908.	1907.
First quarter,	12,471	28.00	26.44
Second quarter,	10,688	24.00	23.55
Third quarter,	11,079	24.88	25.72
Fourth quarter,	10,297	23.12	24.29
Total,	44,535	100.00	100.00

These percentages differ but little from the mean of several years, which usually shows the highest mortality in the third quarter of the

year. As in 1899, 1901, 1903, 1904 and 1907, the highest mortality was in the first quarter.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 697 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

Months.	Deaths in Each Month.	Mean Daily Deaths per Month, 1908.	Centesimal Ratio. 1908.	Centesimal Ratio. 1907.
January,	4,372	141.0	115.9	107.4
February,	3,991	137.6	113.1	108.1
March,	4,108	132.5	108.9	106.3
April,	3,945	131.5	108.1	118.5
May,	3,715	116.6	95.8	91.7
June,	3,028	100.9	82.9	89.0
July,	3,644	117.5	96.5	91.0
August,	3,925	126.6	104.0	114.4
September,	3,510	117.0	96.1	100.9
October,	3,425	110.5	90.8	91.6
November,	3,189	106.3	87.3	86.3
December,	3,683	118.8	97.6	111.0
Annual mean,	–	121.7	100.0	100.0

The figures in the foregoing table indicate a departure in excess of the mean death-rate in January, February, March, April and August, while that of the remaining months was below the mean.

The mean maximum departure from the death-rate for each month for the period of twenty years, 1856–75, was 32.9 per cent. in August, and the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1908, was 4 per cent. and those of January, February, March and April, 1908, were, respectively, 15.9, 13.1, 8.9 and 8.1 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

The figures for 1908, when compared with those of earlier years in the past half-century, show a much greater uniformity in the seasonal mortality, since serious epidemics have not prevailed in the State either in the past year or in any of the years of the past decade.

Death-rates of Cities and Large Towns. — In Table II., last column, the death-rates of cities and towns having over 5,000 inhabitants are given. These death-rates are obtained by comparing the deaths in each city and town with the estimated population. They vary from a minimum of 8.5 in Wellesley to 22.2 per 1,000 in Fall River.

The following cities and towns had death-rates above 19 per 1,000 in 1908: Fall River, 22.2; Blackstone, 20.4; Lowell, 20.4; Newburyport, 20.3; Middleborough, 19.7; Stoughton, 19.5; Natick, 19.3; Hingham, 19.3; Salem, 19.2; New Bedford, 19.1.

Of the foregoing, Fall River, Hingham, Lowell, Middleborough, Blackstone and New Bedford had death-rates above 19 per 1,000 in 1907.

The following cities and towns had death-rates less than 12 per 1,000 in 1908: Maynard, 11.9; Brookline, 11.7; Greenfield, 11.5; Brockton, 11.4; Hyde Park, 11.4; Chelsea, 11.3; Waltham, 11.2; Medford, 11.1; Newton, 11.0; Norwood, 11.0; Orange, 11.0; Hudson, 10.6; Concord, 10.3; Watertown, 10.3; Winchester, 9.1; Wellesley, 8.5; of these, Brookline, Concord, Hyde Park, Wellesley and Winchester also had death-rates below 12 per 1,000 in 1907.

The following table presents the mean death-rates of cities over 25,000 population for the seven census years 1870, 1875, 1880, 1885, 1890, 1895 and 1900, together with the death-rates for the years 1905 and 1908: —

Death-rates of Certain Cities having a Population of More than 25,000. Mean Death-rates of the Seven Census Years 1870, 1875, 1880, 1885, 1890, 1895, 1900, and for 1905 and 1908.

	Mean Death-rates, 1870, 1875, 1880, 1885, 1890, 1895, and 1900.	Death-rate, 1905.	Death-rate, 1908.		Mean Death-rates. 1870, 1875, 1880, 1885, 1890, 1895, and 1900.	Death-rate, 1905.	Death-rate, 1908.
Boston,	23.3	18.5	19.1 [1]	Brockton,	15.3	12.7	11.4
Worcester,	19.5	17.4	17.3 [1]	Haverhill,	17.2	15.5	15.2
Fall River,	22.8	20.2	22.2	Salem,	21.4	19.5	19.2
Lowell,	21.8	20.0	20.4	Chelsea,	19.7	18.4	14.6 [1]
Cambridge,	19.0	15.5	15.8	Malden,	16.4	13.3	13.8
Lynn,	17.4	16.2	14.3	Newton,	14.3	13.1	11.0
Lawrence,	21.7	19.6	16.9	Fitchburg,	16.4	13.1	14.8
New Bedford,	20.7	17.2	19.1	Taunton,	19.7	21.8	21.4 [1]
Springfield,	19.0	15.2	15.0	Gloucester,	20.6	14.8	13.0
Somerville,	17.1	14.0	12.2	Quincy,	17.1	13.1	12.2
Holyoke,	22.2	16.3	17.4	Waltham,	15.0	13.7	11.2

[1] These figures for Boston, Chelsea, Worcester and Taunton include all deaths. By exclusion of deaths of non-residents in Boston and deaths in public and private institutions in the other 3 cities, the death-rates would be reduced to 11.3 in Chelsea, 17.1 in Boston, 17.4 in Taunton and 16.2 in Worcester.

Causes of Death. — In Table III. the mortality of the cities and towns embraced in this summary is presented in absolute figures, classified according to the principal causes of death. The same figures are again presented in relative terms in Table IV., for the whole group of cities and towns combined. Two sets of figures are given in Table IV., in one of which the mortality from each principal cause of death is compared with the estimated population of the group for 1908, as well as for each of the last five years, and in the other with the total mortality of the group of cities and towns.

By this it appears that the general death-rate from all causes, as shown in the lower line at the left of the table, 164.00 per 10,000 living, or, as usually stated, 16.40 per 1,000, was lower than that of any year since 1904, when the rate was 15.46. In the years 1907, 1906 and 1905 it was 17.46, 16.61 and 16.77 respectively. The population comprised in these returns constitutes about 87 per cent. of that of the whole State.

The decline in the general death-rate during the year 1908 is chiefly due to a considerable decrease in the relative number of deaths from infectious diseases, more especially from those which are usually considered preventable.

The death-rate from each of the following causes was less than that of 1907: consumption, diphtheria and croup, cerebro-spinal meningitis, erysipelas, puerperal fever, influenza, malarial fever, diarrhœa and cholera morbus, pneumonia, bronchitis, diseases of the heart, diseases of the brain and spinal cord, diseases of the kidneys and accident. That of consumption, cerebro-spinal meningitis, erysipelas, malarial fever, diarrhœa and cholera morbus and bronchitis was also less than the death-rates from the same causes in any of the last five years.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infectious diseases, and shows that this combined death-rate in 1908 was somewhat higher than that of the four preceding years. The lowest rate previous to 1904 was 30.7 in 1903.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the fourteen years (1895–1908) in the cities and towns included in this report (about six-sevenths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infective Diseases.

Year.	Combined Death-rate per 10,000.	Year.	Combined Death-rate per 10,000.
1895,	46.4	1902,	30.9
1896,	46.8	1903,	30.7
1897,	39.7	1904,	27.0
1898,	36.3	1905,	28.0
1899,	35.2	1906,	27.9
1900,	40.7	1907,	27.8
1901,	33.5	1908,	28.5

The death-rate from consumption was lower in 1908 than in any year of record, being 13.49, as against 15.50 in 1907, 15.11 in 1906, 16.01 in 1905, 16.05 in 1904, 15.66 in 1903 and 16.38 in 1902.

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 721.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past fourteen years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3, 19.9, 19, 19, 17.5, 16.7, 16.8, 15.9 and 17.4 in the fourteen succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6, 40.1, 42.7, 43, 45.7, 46.6, 45.6, 46.3 and 46.7 in the same years.

These all combined constituted the greater part of the total mortality in each of the fifteen years 1894–1908, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

TABLE I.

Population of Cities and Large Towns estimated for 1908.

Reporting Cities and Towns.	Estimated Population for 1908.	Reporting Cities and Towns.	Estimated Population for 1908.
Abington,	5,435	Hudson,	6,676
Adams,	13,375	Hyde Park,	15,327
Amesbury,	8,840	Ipswich,	5,532
Amherst,	5,484	Lawrence,	78,000
Andover,	6,632	Leominster,	15,578
Arlington,	10,307	Lowell,	96,380
Athol,	7,278	Lynn,	82,661
Attleborough,	13,600	Malden,	40,929
Beverly,	16,088	Marblehead,	7,209
Blackstone,	5,825	Marlborough,	14,359
Boston,	617,082	Maynard,	6,813
Braintree,	7,416	Medford,	20,605
Bridgewater,	7,321	Melrose,	15,160
Brockton,	53,131	Methuen,	9,375
Brookline,	25,825	Middleborough,	6,888
Cambridge,	100,922	Milford,	12,565
Chelsea,	39,363	Milton,	7,339
Chicopee,	20,831	Montague,	7,534
Clinton,	13,105	Natick,	9,681
Concord,	5,421	New Bedford,	82,580
Danvers,	9,375	Newburyport,	14,794
Dedham,	7,963	Newton,	38,919
Easthampton,	7,531	North Adams,	22,150
Everett,	32,415	Northampton,	20,789
Fall River,	106,305	North Attleborough,	8,253
Fitchburg,	33,948	Northbridge,	7,619
Framingham,	11,698	Norwood,	7,481
Franklin,	5,379	Orange,	5,614
Gardner,	12,794	Palmer,	7,755
Gloucester,	26,011	Peabody,	14,144
Grafton,	5,160	Pittsfield,	27,168
Great Barrington,	6,329	Plymouth,	12,149
Greenfield,	9,894	Quincy,	30,924
Haverhill,	38,228	Reading,	6,111
Hingham,	4,819	Revere,	14,248
Holyoke,	52,652	Rockland,	6,863

TABLE I. — *Concluded.*

Reporting Cities and Towns.	Estimated Population for 1908.	Reporting Cities and Towns.	Estimated Population for 1908.
Salem,	38,666	Webster,	10,825
Saugus,	6,955	Wellesley,	6,858
Somerville,	74,295	Westborough,	5,378
Southbridge,	11,630	Westfield,	14,457
South Hadley,	5,372	West Springfield,	8,698
Spencer,	7,121	Weymouth,	11,744
Springfield,	81,425	Whitman,	6,740
Stoneham,	6,413	Williamstown,	4,425
Stoughton,	6,268	Winchendon,	6,491
Swampscott,	5,498	Winchester,	8,839
Taunton,	30,967	Winthrop,	7,619
Wakefield,	10,903	Woburn,	14,492
Waltham,	28,120	Worcester,	134,341
Ware,	8,792	Total,	2,715,592
Watertown,	12,306		

The death-rate of Amesbury, Andover, Clinton, Concord, Gloucester, Hingham, Marblehead, Middleborough, North Adams, Palmer, Spencer, Taunton, Westborough and Williamstown was based on the population of 1905, these cities and towns having slightly decreased in population in the five years which elapsed between the census of 1900 and that of 1905.

On account of the fire in Chelsea, in April, 1908, the population is estimated by the city clerk to have fallen off about 6,000. This amount, however, has not been deducted from the total estimated population of this table, as most of these 6,000 people moved into the neighboring cities and towns. In estimating the death-rate for Chelsea, in 1908 the figure as given in this table, 39,363, less 6,000, or 33,363, was used.

While Lowell had fallen off between the two census years, it has, since 1905, made a gain by the annexation of a part of the town of Tewksbury, and this increase is included in the population given above.

Table II.

Total Deaths, Deaths by Sexes, and Age Periods and Still-births in Cities and Towns having over 5,000 Inhabitants in Each with General Death-rates estimated for 1908.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Abington,	87	47	40	–	7	13	2	2	2	–	–	–	2	4	10	7	9	9	17	10	–	16.01
Adams,	197	89	108	–	15	64	9	4	3	2	5	2	6	13	8	17	19	24	15	6	–	14.72
Amesbury,	153	73	80	–	4	25	3	1	2	–	5	3	3	6	14	15	19	18	22	17	–	17.31
Amherst,	94	44	50	–	4	5	1	–	–	–	1	–	4	3	8	3	5	24	27	11	2	17.14
Andover,	84	42	42	–	5	9	2	2	–	–	3	1	–	9	7	2	6	11	21	11	–	12.67
Arlington,	145	68	77	–	9	19	5	3	2	2	3	2	3	12	12	11	19	25	16	11	–	14.06
Athol,	124	76	48	–	11	15	6	3	1	–	3	3	2	13	7	6	11	23	19	12	–	17.04
Attleborough,	166	83	83	–	12	36	3	2	2	–	3	1	5	6	14	16	15	21	23	19	–	12.21
Beverly,	251	157	94	–	17	37	5	3	1	1	4	1	1	23	21	17	25	45	43	23	1	15.60
Blackstone,	119	54	65	–	4	33	2	3	1	4	3	2	2	6	12	5	9	9	20	8	–	20.43
Boston,[1]	11,774	6,213	5,561	–	636	2,742	614	266	159	13	275	143	242	851	1,065	1,208	1,241	1,316	1,015	524	–	17.07[2]
Braintree,	121	56	65	–	4	19	6	2	2	–	2	4	3	4	11	6	15	16	14	16	1	16.32
Bridgewater,[3]	91	45	46	–	–	12	2	2	–	1	2	–	3	5	4	3	9	15	16	17	–	12.43[2]
Brockton,	605	333	272	–	65	137	29	11	6	4	14	10	16	49	40	50	61	70	70	38	–	11.39
Brookline,	301	151	150	–	15	35	–	–	1	1	5	–	4	15	20	22	41	51	67	39	–	11.65
Cambridge,	1,599	796	803	–	100	386	87	28	19	16	31	25	29	116	134	130	157	200	153	88	–	15.84
Chelsea,[4]	487	327	160	–	32	82	24	12	7	7	9	1	8	31	37	35	32	86	82	31	3	11.33[2]

Chicopee,	372	197	175	-	35	142	28	15	5	5	10	2	7	15	23	17	20	35	32	16	-	17.86
Clinton,	205	106	99	-	17	36	6	2	3	3	3	6	4	13	13	14	26	33	29	14	-	15.64
Concord,	56	34	22	-	4	4	5	-	-	-	2	-	1	4	1	8	12	5	5	9	-	10.33
Danvers,[5]	132	63	69	-	4	20	4	-	-	-	-	-	1	5	10	10	21	17	29	15	-	14.08[2]
Dedham,	112	53	59	-	5	12	1	1	1	1	5	1	4	6	6	11	10	19	22	12	-	14.07
Easthampton,	116	54	62	-	6	48	1	-	1	-	2	-	6	3	3	6	7	14	11	14	-	15.40
Everett,	393	212	181	-	35	105	20	4	6	6	10	10	7	15	25	19	49	56	34	27	-	12.12
Fall River,	2,358	1,312	1,046	-	183	681	192	128	68	64	124	78	56	96	140	184	224	172	100	50	1	22.18
Fitchburg,	503	269	234	-	41	155	17	5	5	6	13	8	10	27	34	35	44	46	47	51	-	14.82
Framingham,	167	83	84	-	14	19	3	1	1	-	3	1	10	14	9	15	21	22	27	20	1	14.27
Franklin,	73	33	40	-	5	14	2	1	-	-	1	2	2	4	7	5	4	11	12	8	-	13.57
Gardner,	187	107	80	-	27	54	7	3	2	-	3	2	2	15	19	13	20	19	20	8	-	14.62
Gloucester,	338	170	168	-	36	68	12	5	5	1	-	4	6	27	33	23	42	38	41	32	1	13.00
Grafton,	95	54	41	-	4	12	4	2	3	-	2	4	1	2	8	8	18	10	14	7	-	18.41
Great Barrington,	89	40	49	-	3	17	3	2	1	-	1	1	-	3	5	6	5	15	17	13	-	14.06
Greenfield,	114	58	56	-	8	17	6	1	-	-	1	1	4	11	11	3	8	21	15	15	-	11.52
Haverhill,	580	287	293	-	64	100	14	6	5	3	17	10	18	41	42	42	64	77	91	50	-	15.17
Hingham,	93	50	43	-	2	9	3	-	2	-	2	-	1	3	8	3	9	12	23	18	-	19.30
Holyoke,	916	477	439	-	79	313	55	18	14	10	24	12	21	53	76	62	82	82	59	35	-	17.40
Hudson,	71	35	36	-	9	7	3	-	1	-	1	2	1	3	4	7	6	15	14	7	-	10.64
Hyde Park,	175	94	81	-	18	39	1	5	3	3	4	4	2	8	14	7	16	21	29	19	-	11.42
Ipswich,	87	43	44	-	8	24	3	-	1	-	1	-	2	10	2	4	8	9	15	8	-	15.73
Lawrence,	1,315	634	681	-	125	423	72	17	20	15	31	20	24	94	88	103	100	153	103	51	1	16.86
Leominster,	222	122	100	-	21	51	9	4	2	-	4	2	5	13	11	18	21	26	35	21	-	14.25

[1] Non-residents, 1,243, included.
[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
[3] State Farm, 101, additional.
[4] Soldiers' Home and marine and naval hospitals, 109, included.
[5] Insane Asylum, 225, included.

TABLE II. — *Continued.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Lowell,	1,963	994	969	-	131	554	109	47	21	19	46	14	43	128	146	160	203	210	169	94	-	20.37
Lynn,	1,180	594	586	-	102	238	39	25	13	8	31	20	27	73	90	98	119	174	130	95	-	14.28
Malden,	564	287	277	-	31	109	18	10	5	6	16	9	13	28	41	37	66	78	76	52	-	13.78
Marblehead,	119	61	58	-	8	9	6	1	-	-	1	1	1	4	2	10	12	29	29	14	-	16.51
Marlborough,	204	90	114	-	7	29	6	2	2	-	2	3	7	19	15	19	25	26	31	18	-	14.21
Maynard,	81	48	33	-	12	27	4	-	-	-	2	-	2	7	3	5	9	5	11	6	-	11.89
Medford,	229	107	122	-	21	28	5	1	4	2	11	1	4	15	17	14	28	34	41	24	-	11.11
Melrose,	199	95	104	-	9	31	5	2	3	-	2	2	4	12	12	18	22	29	28	29	-	13.12
Methuen,	153	82	71	-	18	20	5	3	4	4	5	3	1	10	11	12	13	23	17	21	1	16.32
Middleborough,	138	90	48	-	7	24	2	-	-	1	3	2	2	6	10	10	18	22	24	14	-	19.74
Milford,	192	97	95	-	25	39	8	5	2	2	1	2	4	7	21	17	13	21	31	18	1	15.27
Milton,	95	49	46	-	6	13	-	1	2	-	3	3	3	9	5	9	11	14	10	12	-	12.94
Montague,	99	52	45	2	10	29	2	-	-	1	-	1	2	5	10	5	8	17	10	9	-	13.14
Natick,	187	97	90	-	12	17	12	6	3	2	5	1	5	8	9	13	22	31	34	19	-	19.32
New Bedford,	1,579	803	776	-	132	509	110	44	22	14	31	26	27	102	102	93	134	134	144	86	1	19.12
Newburyport,	300	138	162	-	17	39	7	-	1	2	2	5	3	14	29	28	31	40	52	47	-	20.28
Newton,	427	197	230	-	24	76	17	3	3	3	8	6	10	27	21	30	44	69	63	47	-	10.97
North Adams,	288	162	126	-	26	53	4	6	5	1	4	6	8	21	18	32	26	46	37	21	-	13.00
Northampton,[1]	359	174	185	-	14	64	13	-	3	-	10	3	9	17	31	27	31	51	60	40	-	12.89[2]

North Attleborough,	115	67	48	–	6	30	3	1	–	–	–	2	2	5	7	5	9	22	17	12	–	13.93
Northbridge,	124	72	52	–	15	41	6	7	2	–	2	2	3	9	4	4	10	12	18	4	–	16.28
Norwood,	82	39	43	–	5	14	5	2	1	1	3	5	1	7	4	4	7	9	11	8	–	10.96
Orange,	62	25	37	–	10	11	–	–	–	1	1	1	2	2	3	9	5	8	12	7	–	11.04
Palmer,	118	54	64	–	6	35	6	3	4	1	5	2	5	8	8	4	6	12	10	9	–	15.22
Peabody,	224	102	122	–	10	43	9	8	1	3	8	–	8	14	19	24	19	21	30	17	–	15.84
Pittsfield,	423	222	201	–	30	63	8	4	6	2	5	7	11	30	28	37	57	70	60	35	–	15.57
Plymouth,	157	94	63	–	11	42	8	3	1	1	–	1	1	4	4	6	16	25	24	21	–	12.92
Quincy,	377	202	175	–	36	93	14	3	6	5	11	5	8	18	22	32	41	36	52	31	–	12.19
Reading,	86	47	39	–	5	17	3	3	1	–	1	–	–	1	3	2	9	8	16	22	–	14.07
Revere,	193	93	100	–	14	45	14	2	2	1	3	4	7	17	10	17	21	21	23	6	–	13.54
Rockland,	103	52	51	–	2	16	–	1	–	1	1	–	3	2	8	4	12	19	27	9	–	15.01
Salem,	743	358	382	3	40	208	35	23	10	6	19	6	15	25	45	50	71	96	79	52	3	19.21
Saugus,	114	56	58	–	6	38	–	4	–	–	2	2	–	3	5	4	12	15	20	9	–	16.39
Somerville,	903	429	474	–	70	178	36	14	6	7	24	13	18	44	72	53	85	132	153	68	–	12.15
Southbridge,	167	80	86	1	15	47	5	2	2	2	5	3	6	13	16	7	15	13	12	19	–	14.36
South Hadley,	88	33	55	–	7	19	5	–	3	–	–	4	–	6	9	5	7	11	15	4	–	16.38
Spencer,	98	57	41	–	2	15	4	–	–	–	2	1	–	9	10	9	5	8	22	12	1	13.76
Springfield,	1,224	620	604	–	82	213	38	11	7	9	28	18	34	102	96	108	134	164	149	112	1	15.03
Stoneham,	119	56	63	–	11	8	–	–	2	1	1	1	3	6	12	7	13	19	21	25	–	18.56
Stoughton,	122	57	65	–	5	25	5	–	1	1	2	–	3	5	11	9	11	16	19	14	–	19.46
Swampscott,	67	35	32	–	1	8	1	1	–	–	–	1	1	2	4	1	7	14	14	13	–	12.19
Taunton,[3]	662	351	311	–	41	148	12	7	4	2	11	8	9	52	52	48	70	80	91	65	3	17.37[2]
Wakefield,	169	89	80	–	14	36	4	–	1	1	6	3	5	10	6	15	23	20	23	16	–	15.50

[1] State Hospital, 91, included.
[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
[3] Insane Asylum, 124, included.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Waltham,	314	140	174	–	15	45	6	3	2	1	9	10	7	22	31	34	24	43	37	40	–	11.17
Ware,	146	69	77	–	6	37	8	2	5	1	1	2	6	7	10	7	9	11	27	13	–	16.61
Watertown,	127	53	74	–	11	36	4	–	1	–	3	–	5	9	5	9	9	19	16	11	–	10.32
Webster,	145	75	70	–	21	44	8	2	1	3	2	1	5	14	5	8	11	16	16	9	–	13.39
Wellesley,	58	23	35	–	3	6	2	–	–	–	3	1	–	–	4	5	7	8	15	7	–	8.46
Westborough,[1]	170	104	66	–	1	7	–	1	–	–	–	1	1	8	18	28	27	24	38	17	–	13.76[2]
Westfield,	227	121	106	–	19	53	–	2	1	2	4	3	6	14	18	13	18	28	36	29	–	15.70
West Springfield,	132	70	62	–	8	44	3	2	–	1	2	–	–	8	8	7	12	18	14	13	–	15.18
Weymouth,	195	94	101	–	4	28	4	3	3	2	2	4	3	10	8	14	25	31	35	23	–	16.61
Whitman,	87	44	43	–	5	15	–	–	–	1	1	3	3	1	7	5	9	8	17	16	1	12.91
Williamstown,	57	29	28	–	5	10	1	–	–	–	–	–	4	4	–	1	3	9	15	10	–	12.88
Winchendon,	96	46	50	–	11	15	3	1	2	3	4	3	4	1	5	8	8	13	13	12	1	14.79
Winchester,	80	45	35	–	12	12	3	–	–	1	1	1	1	4	7	9	6	11	15	9	–	9.05
Winthrop,	108	53	55	–	11	12	1	1	–	2	–	–	3	6	10	13	22	14	18	6	–	14.15
Woburn,	202	107	95	–	15	33	5	3	3	2	3	2	3	8	13	13	22	40	25	27	–	13.94
Worcester,[3]	2,330	1,259	1,071	–	128	465	78	48	40	22	75	34	50	157	203	209	236	282	259	172	–	16.22
	44,537	23,080	21,451	6	3,024	10,202	1,990	887	568	419	1,065	630	949	2,830	3,419	3,660	4,478	5,370	4,975	3,071	24	16.40

[1] Insane Asylum, 96, included. [2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
[3] Insane Hospital and Insane Asylum, 151, included.

TABLE III.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each, 1908.

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Abington, . . .	7	-	-	-	-	1	1	-	-	1	-	-	1	2	-	6	-	27	13	5	4	1	3	-	15
Adams, ...	22	-	1	1	2	-	1	1	-	-	1	-	2	1	-	15	1	8	12	4	9	3	4	-	109
Amesbury, . . .	15	-	2	-	-	-	3	-	-	-	1	-	8	-	4	12	4	25	21	19	7	3	8	3	18
Amherst, . . .	9	-	-	1	-	1	1	-	-	-	-	1	-	-	-	6	4	30	11	10	6	1	2	-	11
Andover, . . .	4	-	-	-	1	1	1	1	-	-	-	-	-	3	1	9	5	18	8	2	4	2	4	-	20
Arlington, . . .	25	-	2	4	2	-	3	-	-	-	-	-	5	-	-	7	4	23	9	7	10	1	6	-	36
Athol, ...	11	-	2	1	3	-	1	-	-	-	-	-	2	-	1	10	3	20	21	6	7	1	7	-	28
Attleborough, . .	10	-	-	-	1	-	-	1	-	-	3	-	8	-	2	10	1	30	18	11	10	2	3	-	56
Beverly, . . .	13	-	1	-	4	6	6	1	-	-	2	-	3	-	-	28	2	46	20	20	15	-	12	1	71
Blackstone, . . .	17	-	-	-	2	-	-	1	-	1	-	-	7	4	9	17	1	19	13	5	3	1	9	-	10
Boston, ...	1,094	-	151	104	204	82	159	53	48	25	59	4	658	14	127	1,299	226	1,177	1,080	529	628	125	638	306	2,955
Braintree, . . .	9	-	1	-	2	-	1	2	-	-	-	-	2	2	3	16	1	15	15	6	4	1	5	-	36
Bridgewater, . .	5	-	-	-	1	-	-	2	1	-	-	-	-	-	-	14	1	12	12	2	5	1	5	13	17
Brockton, . . .	52	-	-	-	5	3	7	2	3	7	13	-	14	8	1	50	8	80	37	28	30	5	21	1	228
Brookline, . . .	11	-	1	-	1	-	2	-	-	-	-	-	-	-	3	23	9	65	24	20	33	1	3	-	105

TABLE III. — *Continued.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Cambridge,	138	–	10	11	35	28	11	7	3	5	10	–	30	6	98	171	31	187	159	105	82	17	62	82	309
Chelsea,	48	–	9	3	8	4	2	2	–	–	–	–	5	–	3	54	8	48	49	38	27	1	33	–	145
Chicopee,	25	–	–	1	7	1	–	1	–	2	–	–	20	3	5	41	11	33	52	17	10	–	9	5	129
Clinton,	18	–	–	–	–	–	2	–	1	–	–	–	3	1	6	19	4	12	–	7	11	–	6	–	113
Concord,	5	–	–	–	–	–	–	–	–	–	–	–	3	–	–	3	–	14	4	3	2	–	6	–	16
Danvers,	14	–	–	–	–	3	5	–	–	–	–	–	2	2	3	18	6	19	–	2	8	2	4	–	44
Dedham,	5	–	1	–	1	–	–	–	–	–	1	–	–	–	1	12	–	27	16	6	6	4	5	–	26
Easthampton,	6	–	–	1	2	1	1	2	–	–	–	–	5	1	1	12	2	8	4	5	8	–	4	7	46
Everett,	28	–	3	3	11	7	4	–	–	–	5	–	10	1	–	50	10	52	2	1	29	2	4	–	171
Fall River,	142	5	41	40	22	16	13	3	2	7	19	–	190	–	17	275	114	122	259	122	61	4	83	21	780
Fitchburg,	34	–	–	1	9	2	7	1	–	–	3	–	21	4	–	50	13	60	49	18	15	7	21	16	172
Framingham,	9	–	–	–	–	–	2	1	–	–	–	–	3	2	1	20	2	22	12	10	7	–	16	1	59
Franklin,	7	–	–	–	2	–	–	3	–	–	–	–	1	–	–	8	1	7	5	5	2	–	5	–	27
Gardner,	19	–	1	1	3	6	1	–	–	–	5	–	12	–	–	17	2	19	22	5	9	2	8	1	54
Gloucester,	2	–	–	2	1	2	–	1	–	–	–	–	12	–	–	44	5	25	7	11	20	2	2	–	200
Grafton,	6	–	–	4	4	–	1	–	–	–	1	–	3	–	1	6	2	10	5	2	4	–	3	–	43
Great Barrington,	7	–	–	1	–	–	1	–	1	–	–	–	2	–	–	14	3	16	9	5	8	–	1	–	21

Greenfield,	3	–	–	–	1	–	–	5	–	–	–	–	1	–	–	8	–	7	4	8	7	2	7	14	46
Haverhill,	55	–	9	–	3	2	9	1	2	–	7	–	48	–	1	43	7	57	51	42	34	4	28	4	172
Hingham,	–	–	1	–	1	–	–	1	1	–	1	–	1	2	2	4	2	8	–	2	9	1	3	–	54
Holyoke,	79	–	1	7	29	2	5	4	1	–	5	–	44	4	56	101	13	54	48	56	29	10	31	–	335
Hudson,	3	–	–	–	1	1	–	2	–	–	2	–	1	–	–	10	2	11	9	7	7	–	–	–	15
Hyde Park,	12	–	3	1	5	–	3	–	–	–	2	–	3	3	1	19	1	14	16	10	8	–	11	–	63
Ipswich,	9	–	–	–	1	–	3	–	–	–	3	–	7	–	2	10	–	12	11	3	8	–	5	–	13
Lawrence,	126	1	9	2	20	13	20	4	2	8	3	–	98	6	20	152	27	95	91	77	53	7	44	131	303
Leominster,	20	–	5	1	2	–	2	–	1	–	–	–	7	–	1	28	1	24	7	19	16	2	5	–	81
Lowell,	144	–	5	2	21	7	24	12	3	3	8	–	110	4	181	209	77	185	208	93	82	11	53	4	517
Lynn,	110	–	3	9	32	10	17	3	2	5	4	–	23	2	2	118	22	133	124	70	72	11	6	7	392
Malden,	50	–	2	6	15	–	6	7	1	1	–	–	25	3	–	35	11	96	42	42	39	5	10	–	168
Marblehead,	8	–	–	–	–	1	1	–	–	–	–	–	1	–	–	3	–	36	–	10	10	1	1	–	47
Marlborough,	20	–	–	1	1	–	1	–	–	–	–	–	2	1	–	11	1	38	32	7	9	–	5	–	75
Maynard,	12	–	–	–	1	3	–	1	–	–	3	–	5	3	2	10	6	6	2	–	6	2	1	–	18
Medford,	27	–	1	2	2	–	1	–	1	–	–	–	1	–	1	24	4	23	–	–	22	3	5	–	112
Melrose,	15	–	1	–	2	1	2	–	1	1	2	–	–	–	3	14	11	31	23	11	17	3	6	20	35
Methuen,	7	–	–	–	3	–	1	1	–	–	–	–	3	1	–	15	2	16	6	1	4	1	17	5	68
Middleborough,	12	–	–	–	–	1	1	2	–	–	1	–	4	–	–	8	3	34	9	3	6	1	5	3	45
Milford,	18	–	3	–	–	–	1	6	1	1	–	–	–	1	19	22	2	14	1	9	5	1	8	–	80
Milton,	13	–	1	–	–	1	1	3	–	–	–	–	–	–	1	6	1	9	5	2	1	1	2	–	48
Montague,	2	–	–	–	1	–	1	–	–	–	1	–	6	–	–	11	2	11	5	–	4	1	2	–	52
Natick,	4	–	–	–	1	–	–	1	–	1	3	1	4	23	–	24	2	26	24	8	7	2	11	–	45

TABLE III. — *Continued.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
New Bedford, . .	124	–	4	10	13	5	20	4	2	3	2	–	88	–	2	175	59	166	7	58	60	9	2	–	766
Newburyport, . .	17	–	–	2	2	–	13	1	–	–	–	–	7	–	1	28	3	15	12	12	17	–	8	–	162
Newton, . . .	28	–	–	1	6	4	2	4	1	1	5	–	5	2	3	25	4	21	17	25	29	1	10	–	231
North Adams, . .	16	–	2	–	3	1	6	1	1	–	2	–	4	–	2	34	7	29	10	12	18	1	19	–	120
Northampton, . .	17	–	4	3	3	6	2	2	1	1	5	–	7	1	8	24	10	26	60	20	22	4	8	20	104
North Attleborough, .	11	–	–	–	1	–	1	1	–	–	–	–	4	–	6	15	4	15	14	4	5	1	5	–	28
Northbridge, . .	8	–	2	4	2	1	2	5	–	1	–	–	12	–	–	18	1	15	5	8	5	1	6	–	28
Norwood, . . .	7	–	1	1	–	–	–	2	–	–	2	–	3	–	1	12	–	15	7	5	4	1	4	4	13
Orange, . . .	3	–	–	–	2	–	–	–	–	–	–	–	1	–	–	2	5	10	3	11	7	3	–	–	14
Palmer, . . .	13	–	–	5	3	1	1	–	–	–	1	–	5	1	15	7	1	12	9	7	5	1	3	–	27
Peabody, . . .	16	–	6	–	3	1	6	7	1	1	1	–	1	2	2	23	7	27	20	11	12	1	5	–	70
Pittsfield, . . .	32	–	–	3	3	–	6	5	–	1	–	–	22	–	7	54	5	60	42	27	28	1	35	–	87
Plymouth, . . .	9	–	1	–	3	–	–	–	–	–	2	–	8	1	1	11	3	42	16	12	8	1	7	–	32
Quincy, . . .	41	–	–	–	9	–	3	2	2	–	2	–	4	–	30	34	5	62	38	14	21	3	27	16	64
Reading, . . .	5	–	1	–	2	–	–	–	–	–	–	–	3	–	–	9	2	5	9	1	5	1	2	–	41
Revere, . . .	16	–	1	1	4	1	4	2	–	–	–	–	8	1	5	27	4	20	13	19	5	3	10	–	49
Rockland, . . .	11	–	–	–	1	–	–	2	–	–	1	–	4	–	3	5	1	15	4	10	7	–	6	–	33
Salem, ...	48	–	8	1	8	5	5	4	1	–	5	–	24	3	9	86	18	77	37	43	45	3	20	3	289

Saugus, ...	6	–	–	1	2	1	–	2	–	–	–	–	1	2	5	11	4	17	1	–	4	1	5	–	51
Somerville, . . .	71	–	2	4	11	7	9	4	3	–	6	–	14	4	3	142	27	104	67	67	75	6	20	–	254
Southbridge, . .	17	–	–	–	2	1	2	–	–	–	–	–	5	2	3	25	4	11	5	7	8	1	1	45	28
South Hadley, . .	7	–	–	–	1	1	–	1	–	–	1	–	6	–	1	10	2	12	12	9	2	–	2	–	21
Spencer, . . .	9	–	–	–	–	1	1	1	–	–	–	–	1	2	–	6	3	27	10	6	6	–	2	–	23
Springfield, . . .	70	–	1	8	24	2	22	2	1	3	22	1	26	1	35	97	17	105	87	131	84	18	71	3	393
Stoneham, . . .	7	–	–	–	–	–	–	4	–	–	–	–	2	3	1	14	2	20	17	11	10	1	6	–	21
Stoughton, . . .	9	–	1	–	2	2	–	2	1	–	–	–	5	3	–	14	4	6	–	2	5	1	3	–	62
Swampscott, . .	8	–	–	1	–	–	1	1	–	–	–	–	–	–	–	7	2	9	2	3	2	–	4	–	26
Taunton, ...	65	–	3	9	1	4	6	–	5	1	8	–	16	1	49	46	19	69	100	21	21	3	1	2	212
Wakefield, . . .	19	–	–	2	1	1	3	–	1	–	–	–	1	–	6	7	3	22	22	4	11	1	8	–	55
Waltham, ...	31	–	2	3	3	–	3	3	–	–	7	–	2	–	–	38	7	32	15	6	18	2	4	–	138
Ware, ...	19	–	–	–	3	–	–	4	–	–	2	–	7	1	2	12	5	18	–	4	4	1	6	–	58
Watertown, . . .	13	–	–	–	–	1	–	–	2	–	4	–	–	–	7	17	–	9	10	3	8	1	1	10	41
Webster, ...	14	–	–	2	–	5	1	–	–	–	2	–	5	1	10	14	3	10	17	10	5	2	10	1	33
Wellesley, . . .	4	–	–	–	1	–	–	–	–	–	1	–	–	1	5	6	3	12	4	3	1	1	3	–	13
Westborough, . .	15	–	–	–	–	–	–	–	–	–	2	–	1	1	1	25	1	31	48	10	8	5	4	4	14
Westfield, . . .	18	–	1	1	1	–	4	–	–	–	–	–	1	–	–	16	1	21	16	21	7	4	5	–	110
West Springfield, . .	8	–	–	1	3	–	–	4	1	–	–	–	11	–	–	11	2	8	4	4	3	1	6	–	65
Weymouth, . . .	17	–	–	–	5	1	1	2	–	–	6	–	2	1	1	20	1	24	24	19	16	1	8	4	42
Whitman, ...	4	–	–	–	–	–	–	4	–	1	1	–	–	1	2	11	3	13	10	5	3	2	–	–	27
Williamstown, . .	3	–	–	–	1	–	–	–	–	–	4	–	2	–	–	5	–	8	4	1	2	–	–	–	27
Winchendon, . .	3	–	–	2	2	–	4	1	–	–	–	–	2	–	–	7	2	11	10	3	7	–	5	–	37
Winchester, . . .	8	–	–	–	–	–	–	–	–	1	–	–	–	–	2	11	3	6	7	3	3	–	2	–	34

TABLE III. — *Concluded.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Winthrop,	7	-	-	-	1	-	1	1	-	-	-	-	1	-	-	3	-	9	6	7	9	1	2	-	60
Woburn,	17	-	-	-	2	1	1	-	-	-	1	-	1	-	3	19	2	25	21	15	6	-	6	1	81
Worcester,	205	-	21	38	57	14	14	37	11	8	19	-	175	1	23	181	47	227	283	107	130	23	100	-	609
	3,662	6	331	313	666	273	479	253	109	90	282	7	1,923	143	833	4,585	987	4,714	3,811	2,297	2,300	369	1,729	758	13,547

	Homicide.
Arlington,	1
Boston,	22
Brockton,	2
Cambridge,	1
Clinton,	2
Dedham,	1
Gloucester,	2
Greenfield,	1
Haverhill,	1
Holyoke,	2
Lawrence,	3
Lynn,	3
Methuen,	2
Newton,	1
Northampton,	1
Orange,	1
Palmer,	1
Peabody,	1
Pittsfield,	4
Salem,	1
Somerville,	3
Swampscott,	1
Wakefield,	2
	59

	Actinomycosis.
Boston,	1

	Hydrophobia.
Boston,*	2
Newton,	1
	3

	Malignant Pustule.
Boston,	2

	Anthrax.
Cambridge,	1

	Glanders.
Boston,	1

	Tetanus.
Pittsfield,	1

	Beri-beri.
Boston (brought from India),	1

TABLE IV.

Deaths from Specified Causes, 1908, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1904–08), Deaths per 1,000 from All Causes, 1904–08.

Causes of Death.	Deaths 1908	Mortality per 10,000 of the Population.					Deaths per 1,000 from All Causes.				
		1908	1907	1906	1905	1904	1908	1907	1906	1905	1904
Consumption,	3,662	13.49	15.50	15.11	16.01	16.05	82.20	88.75	91.00	95.46	103.76
Smallpox,	6	0.02	0.01	–	0.008	0.03	0.13	0.09	–	0.046	0.20
Measles,	331	1.22	0.55	0.58	0.61	0.63	7.43	3.13	3.49	3.62	4.04
Scarlet fever,	313	1.15	1.00	0.43	0.43	0.43	7.02	5.72	2.60	2.56	2.77
Diphtheria and croup,	666	2.45	2.61	2.50	2.20	2.38	14.95	14.90	15.03	13.13	15.39
Whooping cough,	273	1.01	0.81	1.72	0.64	0.45	6.13	4.65	10.35	3.78	2.92
Typhoid fever,	479	1.76	1.25	1.64	1.87	1.59	10.76	7.14	9.87	11.15	10.29
Cerebro-spinal meningitis,	253	0.93	1.98	1.78	2.36	1.13	5.68	11.36	10.71	14.10	7.28
Erysipelas,	109	0.40	0.49	0.43	0.52	0.58	2.45	2.81	2.58	3.11	3.77
Puerperal fever,	90	0.33	0.39	0.28	0.34	0.27	2.02	2.23	1.71	2.00	1.72
Influenza,	282	1.04	1.56	0.51	1.22	0.77	6.33	8.91	3.08	7.26	4.97
Malarial fever,	7	0.03	0.08	0.06	0.13	0.11	0.16	0.47	0.36	0.78	0.74
Cholera infantum,	1,923	7.08	5.71	5.59	5.88	5.21	43.18	32.67	33.70	35.05	33.67
Dysentery,	143	0.53	0.53	0.58	0.62	0.63	3.21	3.04	3.49	3.71	4.07
Diarrhœa and cholera morbus.	833	3.07	4.73	4.10	4.15	3.59	18.70	27.06	24.72	24.74	23.21
Pneumonia,	4,585	16.88	17.98	17.72	17.75	15.85	102.94	102.98	106.72	105.85	102.46
Bronchitis,	987	3.63	4.31	4.19	4.31	4.23	22.16	24.68	25.27	25.69	27.37
Diseases of the heart,	4,714	17.36	18.43	17.00	17.36	16.21	105.84	105.52	102.40	103.50	104.79
Diseases of the brain and spinal cord.	3,811	14.03	14.10	12.46	14.74	12.56	85.57	80.72	75.03	87.88	81.24
Diseases of the kidneys,	2,297	8.46	9.15	8.95	9.01	8.24	51.58	52.38	53.90	53.75	53.30
Cancer,	2,300	8.47	8.37	8.13	7.97	7.34	51.64	47.93	48.98	47.55	47.49
Suicide,	369	1.36	1.35	1.00	1.09	1.03	8.29	7.74	6.01	6.52	6.69
Accident,	1,729	6.37	7.19	6.29	5.88	5.14	38.82	41.16	37.87	35.06	33.25
Unknown or ill-defined causes.	758	2.79	2.15	1.98	2.00	1.70	17.02	12.30	11.95	11.96	10.98
All causes,	44,537	164.00	174.65	166.10	167.67	154.65	–	–	–	–	–

IV.

Official Returns of Deaths in Cities and Large Towns (Revised Laws, Chapter 75, Section 12).

1909.

In the following summary, the statistics of deaths required by chapter 75, section 12, of the Revised Laws, are presented. These statistics are returned to the Board from each city and town which has, "according to the latest census, more than five thousand inhabitants."

The cities and towns which have contributed these returns for the year 1909 comprise the same list as that of 1908. This list embraces all of the 33 cities and the towns having more than 5,000 inhabitants in each.

Hingham and Williamstown have again made returns, although their populations fell below 5,000 in 1905.

The list for the year 1909 includes 100 cities and towns. The total estimated population of this group of cities and towns in 1909, based upon the rate of growth between the two census years 1900 and 1905, was 2,759,822, or about 87 per cent. of the estimated total population of the State.

The whole number of registered deaths in these cities and towns in 1909 was 43,929, and the death-rate, as calculated from the foregoing estimated population, was 15.92 per 1,000 of the living population, that of the previous year having been 16.40 per 1,000, and that of 1907, 17.46 per 1,000.

The death-rate for the year 1909 was lower than that of 1908, and considerably lower than the mean annual death-rate of the State for the fifty years ended Dec. 31, 1900, which was 19.22 per 1,000.

Sexes. — The number of deaths of males was 22,515, or 51.26 per cent. of the whole number of deaths whose sex was known; and the deaths of females were 21,405, or 48.74 per cent. There were 9 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows: —

Ages.	Deaths, 1909.	Percentages of All Deaths.	
		1909.	1908.
Under 1 year,	9,498	21.63	22.92
1 to 20 years,	5,662	12.90	14.62
20 to 50 years,	10,271	23.39	22.26
50 and over,	18,479	42.08	40.20

Infant Mortality. — The deaths of infants under one year old were 9,498, or 21.63 per cent. of the total mortality, as compared with 22.92 per cent. in 1908. In the year 1900 the rate was 23; that of the five years 1905–09, respectively, constituted 21.27, 22.06, 21.55, 22.92 and 21.63 per cent. of the total mortality.

The deaths of children under five years old were 12,768, or 29.1 per cent. of the total mortality, as compared with 31.6 per cent. for the same age in 1908.

All of the percentages in the foregoing table were estimated upon the number of deaths of those whose ages were stated in the returns. The total number of deaths in which the age was not specified was 19; in 1908 it was 24.

Still-births. — The number of still-births was 3,007, and when compared with the total mortality (still-births included), this was 6.4 per cent. of the total deaths and still-births combined. In 1908 the percentage was 6.4.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths, 1909.	Percentages.	
		1909.	1908.
First quarter,	11,517	26.22	28.00
Second quarter,	10,835	24.67	24.00
Third quarter,	10,891	24.79	24.88
Fourth quarter,	10,682	24.32	23.12
Total,	43,925	100.00	100.00

These percentages differ but little from the mean of several years, which usually shows the highest mortality in the third quarter of the year. As in 1907 and 1908, the highest mortality was in the first quarter.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 697 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

Months.	Deaths in Each Month.	Mean Daily Deaths per Month, 1909.	Centesimal Ratio.	
			1909.	1908.
January,	3,800	122.6	101.8	115.9
February,	3,522	125.8	104.5	113.1
March,	4,195	135.3	112.4	108.9
April,	3,813	127.1	105.6	108.1
May,	3,716	119.9	99.6	95.8
June,	3,306	110.2	91.5	82.9
July,	3,429	110.6	91.9	96.5
August,	3,963	127.8	106.1	104.0
September,	3,499	116.6	96.8	96.1
October,	3,467	111.8	92.9	90.8
November,	3,339	111.3	92.4	87.3
December,	3,876	125.0	103.8	97.6
Annual mean,	–	120.4	100.0	100.0

The figures in the foregoing table indicate a departure in excess of the mean death-rate in January, February, March, April, August and December, while that of the remaining months was below the mean.

The mean maximum departure from the death-rate for each month for the period of twenty years, 1856–75, was 32.9 per cent. in August, and the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1909, was 6.1 per cent. and those of February and March, 1909, were, respectively, 4.5 and 12.4 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

The figures for 1909, when compared with those of earlier years in the past half-century, show a much greater uniformity in the seasonal mortality, since serious epidemics have not prevailed in the State either in the past year or in any of the years of the past decade.

Death-rates of Cities and Large Towns. — In Table II., last column, the death-rates of cities and towns having over 5,000 inhabitants are given. These death-rates are obtained by comparing the deaths in each city and town with the estimated population. They vary from a minimum of 7.8 in Wellesley to 22.9 per 1,000 in Grafton.

The following cities and towns had death-rates above 19 per 1,000 in 1909: Grafton, 22.9; Methuen, 19.8; Lowell, 19.6.

Of the foregoing, Lowell had a death-rate above 19 per 1,000 in 1908.

The following cities and towns had death-rates less than 12 per 1,000 in 1909: Maynard, 11.9; Reading, 11.7; Everett, 11.6; Brookline, 11.5; Wakefield, 11.4; Brockton, 11.4; Northampton, 11.3; Newton, 11.2; Hyde Park, 11.1; Swampscott, 10.9; Norwood, 10.6; South Hadley, 10.2; Westborough, 10.0; Concord, 9.8; Hudson, 9.7; Winchester, 8.1; Wellesley, 7.8. Of these, Brockton, Brookline, Concord, Hudson, Hyde Park, Maynard, Newton, Norwood, Wellesley and Winchester had death-rates below 12 per 1,000 in 1908.

The following table presents the mean death-rates of cities over 25,000 population for the seven census years 1870, 1875, 1880, 1885, 1890, 1895 and 1900, together with the death-rates for the years 1905 and 1909: —

Death-rates of Certain Cities having a Population of More than 25,000. Mean Death-rates of the Seven Census Years 1870, 1875, 1880, 1885, 1890, 1895, 1900, and for 1905 and 1909.

	Mean Death-rates, 1870, 1875, 1880, 1885, 1890, 1895, and 1900.	Death-rate, 1905.	Death-rate, 1909.		Mean Death-rates, 1870, 1875, 1880, 1885, 1890, 1895, and 1900.	Death-rate, 1905.	Death-rate, 1909.
Boston,	23.3	18.5	17.8 [1]	Brockton,	15.3	12.7	11.4
Worcester,	19.5	17.4	16.2 [1]	Haverhill,	17.2	15.5	16.3
Fall River,	22.8	20.2	18.5	Salem,	21.4	19.5	17.8
Lowell,	21.8	20.0	19.6	Chelsea,	19.7	18.4	17.5 [1]
Cambridge,	19.0	15.5	15.2	Malden,	16.4	13.3	12.6
Lynn,	17.4	16.2	14.2	Newton,	14.3	13.1	11.2
Lawrence,	21.7	19.6	17.8	Fitchburg,	16.4	13.1	13.8
New Bedford,	20.7	17.2	18.6	Taunton,	19.7	21.8	23.1 [1]
Springfield,	19.0	15.2	15.5	Gloucester,	20.6	14.8	12.5
Somerville,	17.1	14.0	13.0	Quincy,	17.1	13.1	12.3
Holyoke,	22.2	16.3	18.5	Waltham,	15.0	13.7	13.7

[1] These figures for Boston, Chelsea, Worcester and Taunton include all deaths. By exclusion of deaths of non-residents in Boston and deaths in public and private institutions in the other 3 cities, the death-rates would be reduced to 12.3 in Chelsea, 15.6 in Boston, 18.6 in Taunton and 15.9 in Worcester.

Causes of Death. — In Table III. the mortality of the cities and towns embraced in this summary is presented in absolute figures, classified according to the principal causes of death. The same figures are again presented in relative terms in Table IV., for the whole group of cities and towns combined. Two sets of figures are given in Table IV., in one of which the mortality from each principal cause of death is compared with the estimated population of the group for 1909, as well as for each

of the last five years, and in the other with the total mortality of the group of cities and towns.

By this it appears that the general death-rate from all causes, as shown in the lower line at the left of the table, 159.17 per 10,000 living, or, as usually stated, 15.92 per 1,000, was lower than that of any year since 1904, when the rate was 15.46. In the years 1908, 1907, 1906 and 1905, it was 16.40, 17.46, 16.61 and 16.77 respectively. The population comprised in these returns constitutes about 87 per cent. of that of the whole State.

The decline in the general death-rate during the year 1909 is chiefly due to a decrease in the relative number of deaths from infectious diseases, more especially from those which are usually considered preventable.

The death-rate from each of the following causes was less than that of 1908: consumption, measles, scarlet fever, diphtheria and croup, whooping cough, typhoid fever, cerebro-spinal meningitis, influenza, diarrhœa and cholera morbus, pneumonia, bronchitis, diseases of the heart, diseases of the brain and spinal cord, cancer, suicide and accident. That of consumption, cerebro-spinal meningitis, diarrhœa and cholera morbus, pneumonia and bronchitis was also less than the death-rates from the same causes in any of the last five years.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infectious diseases, and also shows that this combined death-rate in 1909 was less, with the exception of 1904, than that of any of the years embraced in this series of reports.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the fifteen years (1895–1909) in the cities and towns included in this report (about six-sevenths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infective Diseases.

Year.	Combined Death-rate per 10,000.	Year.	Combined Death-rate per 10,000.
1895,	46.4	1903,	30.7
1896,	46.8	1904,	27.0
1897,	39.7	1905,	28.0
1898,	36 3	1906,	27.9
1899,	35.2	1907,	27.8
1900,	40.7	1908,	28.5
1901,	33 5	1909,	27.1
1902,	30.9		

The death-rate from consumption was lower in 1909 than in any year of record, being 13.38, as against 13.49 in 1908, 15.50 in 1907, 15.11 in 1906 and 16.01 in 1905.

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 741.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past fifteen years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3, 19.9, 19, 19, 17.5, 16.7, 16.8, 15.9, 17.4 and 17.0 in the fifteen succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6, 40.1, 42.7, 43, 45.7, 46.6, 45.6, 46.3, 46.7 and 47.5 in the same years.

These all combined constituted the greater part of the total mortality in each of the sixteen years 1894–1909, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

Table I.

Population of Cities and Large Towns estimated for 1909.

Reporting Cities and Towns.	Estimated Population for 1909.	Reporting Cities and Towns.	Estimated Population for 1909.
Abington,	5,553	Athol,	7,305
Adams,	13,685	Attleborough,	13,913
Amesbury,	8,840	Beverly,	16,386
Amherst,	5,541	Blackstone,	5,838
Andover,	6,632	Boston,	624,491
Arlington,	10,520	Braintree,	7,595

TABLE I. — *Continued.*

Reporting Cities and Towns.	Estimated Population for 1909.	Reporting Cities and Towns.	Estimated Population for 1909.
Bridgewater,	7,510	Methuen,	9,608
Brockton,	55,039	Middleborough,	6,888
Brookline,	26,574	Milford,	12,722
Cambridge,	102,112	Milton,	7,434
Chelsea,	40,080	Montague,	7,707
Chicopee,	21,049	Natick,	9,705
Clinton,	13,105	New Bedford,	85,516
Concord,	5,421	Newburyport,	14,834
Danvers,	9,479	Newton,	39,642
Dedham,	8,026	North Adams,	22,150
Easthampton,	7,772	Northampton,	21,075
Everett,	33,597	North Attleborough,	8,378
Fall River,	106,486	Northbridge,	7,692
Fitchburg,	34,263	Norwood,	7,731
Framingham,	11,749	Orange,	5,626
Franklin,	5,424	Palmer,	7,755
Gardner,	13,066	Peabody,	14,512
Gloucester,	26,011	Pittsfield,	27,932
Grafton,	5,196	Plymouth,	12,514
Great Barrington,	6,388	Quincy,	31,937
Greenfield,	10,140	Reading,	6,254
Haverhill,	38,362	Revere,	14,820
Hingham,	4,819	Rockland,	7,055
Holyoke,	53,590	Salem,	39,019
Hudson,	6,829	Saugus,	7,189
Hyde Park,	15,609	Somerville,	76,049
Ipswich,	5,641	Southbridge,	11,848
Lawrence,	80,000	South Hadley,	5,478
Leominster,	16,030	Spencer,	7,121
Lowell,	96,380	Springfield,	84,237
Lynn,	84,623	Stoneham,	6,440
Malden,	41,941	Stoughton,	6,371
Marblehead,	7,209	Swampscott,	5,617
Marlborough,	14,456	Taunton,	30,967
Maynard,	7,147	Wakefield,	11,124
Medford,	20,921	Waltham,	28,761
Melrose,	15,459	Ware,	8,858

TABLE I. — *Concluded.*

Reporting Cities and Towns.	Estimated Population for 1909.	Reporting Cities and Towns.	Estimated Population for 1909.
Watertown,	12,676	Williamstown,	4,425
Webster,	11,109	Winchendon,	6,677
Wellesley,	7,081	Winchester,	9,038
Westborough,	5,378	Winthrop,	7,814
Westfield,	14,750	Woburn,	14,522
West Springfield,	8,897	Worcester,	136,476
Weymouth,	11,798	Total,	2,759,822
Whitman,	6,813		

The death-rate of Amesbury, Andover, Clinton, Concord, Gloucester, Hingham, Marblehead, Middleborough, North Adams, Palmer, Spencer, Taunton, Westborough and Williamstown is based on the population of 1905, these cities and towns having slightly decreased in population in the five years which elapsed between the census of 1900 and that of 1905.

The estimate of the population of the city of Chelsea for 1909, as given by the city clerk, is about 30,000, which estimate has been used as a basis for the death-rate in 1909. The estimate of the State Board of Health was 40,080, and this figure has been allowed to stand in the total reporting population, for the same reason as in 1908. (See page 727.)

While Lowell had fallen off between the two census years, it has, since 1905, made a gain by the annexation of a part of the town of Tewksbury, and this increase is included in the population given above.

TABLE II.

Total Deaths, Deaths by Sexes, and Age Periods and Still-births in Cities and Towns having over 5,000 Inhabitants in Each with General Death-rates estimated for 1909.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Abington,	89	44	44	1	1	13	1	2	-	-	1	-	2	8	7	9	7	14	15	10	-	16.03
Adams,	180	100	80	-	23	50	9	4	3	2	3	2	3	11	14	14	18	19	13	15	-	13.15
Amesbury,	158	81	77	-	10	18	1	-	1	-	3	5	4	12	13	16	13	19	36	17	-	17.87
Amherst,	76	34	42	-	1	11	2	-	-	-	-	1	1	3	5	4	10	10	16	13	-	13.72
Andover,	96	46	50	-	1	12	2	-	-	-	-	1	2	6	4	7	14	14	19	15	-	14.48
Arlington,	157	79	78	-	7	8	4	4	2	-	4	2	2	16	13	19	18	17	27	21	-	14.92
Athol,	123	61	61	1	13	21	1	1	2	1	3	4	4	8	6	7	7	11	19	27	1	16.84
Attleborough,	189	95	94	-	12	47	5	3	1	1	3	2	7	13	15	8	20	14	34	16	-	13.59
Beverly,	284	124	160	-	26	41	16	4	5	6	9	3	4	16	20	27	23	38	44	28	-	17.33
Blackstone,	76	36	40	-	7	17	-	1	-	1	1	2	2	4	8	14	6	10	8	2	-	13.02
Boston,[1]	11,057	5,792	5,265	-	708	2,124	468	224	127	85	220	143	226	778	1,115	1,241	1,286	1,371	1,065	584	-	15.62[2]
Braintree,	104	46	58	-	6	15	2	1	1	-	2	3	1	7	7	8	9	14	18	15	1	13.69
Bridgewater,[3]	94	46	48	-	-	16	-	-	1	1	1	-	1	10	6	7	8	11	19	13	-	12.51[2]
Brockton,	625	318	307	-	45	161	23	6	5	3	14	6	14	35	52	62	61	66	69	48	-	11.36
Brookline,	306	134	172	-	11	19	6	1	-	2	4	3	4	11	22	29	38	55	66	46	-	11.47
Cambridge,	1,547	764	783	-	84	322	72	20	14	12	36	25	27	110	135	136	148	210	180	97	3	15.15
Chelsea,[4]	524	358	166	-	34	94	12	5	6	3	14	2	14	21	40	57	30	95	92	39	-	12.33[2]

Chicopee,	394	206	188	-	37	154	26	6	7	4	8	1	6	21	26	18	35	36	29	17	-	18.72
Clinton,	191	90	101	-	14	35	10	3	3	-	6	-	2	13	20	13	20	37	19	10	-	14.57
Concord,	53	25	28	-	3	6	1	1	-	-	-	1	2	1	9	3	4	8	11	6	-	9.78
Danvers,[5]	134	56	78	-	8	20	-	1	-	1	1	2	3	7	8	17	9	18	23	23	1	14.14[2]
Dedham,	97	43	54	-	13	10	4	3	1	1	6	1	-	5	7	3	11	13	17	15	-	12.09
Easthampton,	110	58	52	-	3	24	5	5	1	1	3	1	1	6	4	10	11	11	18	9	-	14.28
Everett,	391	191	200	-	20	60	20	5	4	4	15	4	6	18	31	35	53	54	62	20	-	11.64
Fall River,	1,966	1,074	892	-	187	820	71	60	44	33	42	61	30	147	126	159	129	123	81	40	-	18.46
Fitchburg,	471	255	216	-	50	124	26	13	7	5	7	4	6	25	34	33	44	51	43	49	-	13.75
Framingham,	210	105	105	-	12	33	9	3	2	6	11	1	2	13	13	15	18	30	29	23	2	17.87
Franklin,	75	36	39	-	1	7	-	-	-	1	-	2	1	3	4	5	9	16	17	10	-	13.83
Gardner,	203	106	96	1	21	40	3	2	1	-	7	1	3	14	26	12	26	22	29	17	-	15.53
Gloucester,	326	159	167	-	11	60	8	6	4	1	7	7	4	22	28	18	34	51	48	28	-	12.53
Grafton,	119	67	52	-	3	22	4	1	-	1	3	1	1	2	12	14	15	18	15	10	-	22.88
Great Barrington,	82	45	37	-	5	17	1	-	3	1	1	4	1	4	7	3	12	10	13	5	-	12.83
Greenfield,	122	57	65	-	8	17	2	2	-	1	1	1	3	5	4	10	21	20	18	17	-	12.03
Haverhill,	625	320	305	-	37	96	18	15	5	7	14	7	16	32	44	63	67	93	92	56	-	16.29
Hingham,	81	44	37	-	2	7	1	-	-	-	-	1	1	2	4	5	12	12	16	20	-	16.80
Holyoke,	992	520	472	-	76	366	38	11	11	9	17	10	29	55	72	93	95	79	75	32	-	18.51
Hudson,	66	39	27	-	5	13	1	2	-	-	-	1	-	3	6	8	5	10	11	6	-	9.66
Hyde Park,	173	93	80	-	13	35	5	2	1	1	2	2	1	8	13	12	16	31	28	16	-	11.08
Ipswich,	96	56	40	-	9	23	3	-	1	1	3	1	1	3	5	3	3	15	23	11	-	17.02
Lawrence,	1,424	727	697	-	139	461	104	41	14	15	29	13	34	96	107	118	112	143	96	41	-	17.80
Leominster,	279	138	141	-	19	61	7	3	-	1	9	3	4	18	14	23	27	41	34	31	-	17.40

[1] Non-residents, 1,304, included.
[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
[3] State Farm, 134, additional.
[4] Soldiers' Home and Marine and Naval Hospitals, 154, included.
[5] Insane Asylum, 207, additional.

TABLE II. — *Continued.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Lowell,	1,885	922	963	–	134	494	99	37	23	18	45	29	29	103	178	156	166	215	194	99	–	19.56
Lynn,	1,199	599	600	–	99	204	29	24	10	9	30	20	22	82	88	98	134	187	175	86	1	14.17
Malden,	527	246	281	–	46	99	14	6	11	5	13	6	10	31	42	50	45	73	85	37	–	12.57
Marblehead,	125	69	56	–	6	15	4	–	1	–	2	–	1	8	3	9	14	23	26	19	–	17.34
Marlborough,	221	113	108	–	12	39	3	5	2	2	5	3	5	14	17	14	24	36	34	18	–	15.28
Maynard,	85	47	38	–	12	32	5	2	–	1	2	–	–	11	5	5	8	4	4	6	–	11.89
Medford,	273	120	153	–	23	43	2	4	3	2	6	4	6	11	17	24	33	40	46	32	–	13.05
Melrose,	209	80	129	–	5	24	3	3	–	1	4	2	5	12	11	20	28	30	33	33	–	13.52
Methuen,	190	95	95	–	14	36	9	2	1	1	3	3	3	13	13	10	23	28	26	18	1	19.77
Middleborough,	120	62	58	–	1	15	3	7	1	3	5	3	1	4	1	9	15	20	19	14	–	17.42
Milford,	193	89	104	–	12	28	5	3	2	2	8	–	2	12	17	17	17	26	33	21	–	15.17
Milton,	91	55	36	–	4	11	2	1	2	1	1	1	1	6	5	2	14	14	15	15	–	12.25
Montague,	120	73	45	2	8	26	1	1	1	2	–	–	2	9	5	17	12	17	19	8	–	15.56
Natick,	150	73	77	–	13	16	2	1	2	1	1	3	1	8	18	12	17	27	28	13	–	15.45
New Bedford,	1,594	819	775	–	121	543	129	40	14	11	37	23	26	104	107	89	103	156	125	87	–	18.64
Newburyport,	260	124	136	–	15	23	7	2	–	3	3	4	5	15	19	29	33	29	44	44	–	17.53
Newton,	443	211	232	–	30	76	10	7	5	3	6	10	6	25	33	29	48	68	65	52	–	11.18
North Adams,	365	201	164	–	28	81	13	5	2	3	4	6	12	24	34	26	40	46	43	26	–	16.48
Northampton,[1]	335	182	153	–	12	51	5	–	6	2	5	2	10	22	27	37	43	49	50	26	–	11.29[2]

North Attleborough, .	129	58	71	-	14	23	8	3	1	1	-	1	4	6	4	8	15	19	18	18	-	15.39
Northbridge, . . .	135	73	62	-	10	50	5	-	1	-	1	-	-	7	6	14	15	12	18	6	-	17.56
Norwood, . . .	82	46	36	-	14	14	3	2	-	1	5	5	3	6	7	3	10	13	6	4	-	10.61
Orange, ...	75	43	32	-	1	12	4	3	-	1	2	-	-	5	4	7	11	9	9	8	-	13.32
Palmer, ...	120	68	52	-	7	43	10	6	2	4	2	-	-	9	6	3	11	10	11	3	-	15.46
Peabody, . . .	225	124	101	-	20	36	4	1	1	2	5	3	3	13	20	23	33	33	32	16	-	15.51
Pittsfield, . . .	446	232	214	-	32	84	15	3	-	1	10	8	13	44	40	47	59	48	46	27	1	15.97
Plymouth, . . .	210	106	104	-	4	34	11	5	1	2	2	-	6	7	19	9	21	30	42	21	-	16.79
Quincy, . . .	394	211	183	-	28	86	16	4	6	-	10	11	6	21	32	36	41	55	44	25	1	12.34
Reading, . . .	73	33	40	-	3	4	1	-	1	-	1	3	3	1	3	4	12	12	16	11	1	11.68
Revere, ...	240	130	110	-	16	54	10	3	6	2	5	2	5	16	24	20	24	30	29	10	-	16.19
Rockland, . . .	94	45	49	-	7	8	3	-	-	-	-	2	4	3	10	7	9	15	22	11	-	13.31
Salem, ...	695	343	352	-	45	143	27	9	4	3	13	11	15	38	47	48	79	106	88	61	3	17.81
Saugus, ...	115	52	63	-	12	21	2	-	1	-	1	1	1	8	9	6	13	19	17	16	-	15.99
Somerville, . . .	988	471	517	-	64	169	29	18	5	9	20	16	22	52	72	73	94	145	175	89	-	12.99
Southbridge, . . .	163	65	98	-	6	54	9	6	3	-	5	-	3	6	12	12	15	7	20	10	1	13.76
South Hadley, . .	56	32	24	-	8	12	2	2	1	-	-	-	1	4	4	7	6	4	10	3	-	10.22
Spencer, ...	106	50	56	-	12	11	1	-	-	-	-	-	1	7	5	6	16	21	21	17	-	14.89
Springfield, . . .	1,309	658	651	-	65	261	38	20	15	14	33	22	34	92	105	115	146	187	135	92	-	15.54
Stoneham, . . .	107	53	54	-	3	7	4	-	-	1	1	2	2	4	6	10	9	26	23	12	-	16.61
Stoughton, . . .	96	49	47	-	3	19	3	1	1	-	1	1	3	7	8	2	12	10	20	8	-	15.07
Swampscott, . . .	61	38	23	-	6	8	-	1	-	-	1	1	1	3	7	4	9	11	10	5	-	10.85
Taunton,[3] . . .	715	341	374	-	38	146	25	11	10	2	10	12	12	38	52	79	72	89	97	60	-	18.57[2]
Wakefield, . . .	127	61	66	-	9	23	6	2	-	-	-	1	1	7	12	5	17	15	26	12	-	11.42

[1] State Hospital, 97, included.

[2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.

[3] Insane Asylum, 140, included.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Waltham,	393	200	193	-	19	53	18	4	-	4	16	10	15	33	35	33	43	45	56	27	1	13.66
Ware,	127	68	59	-	7	35	11	1	2	1	3	1	2	7	8	9	9	17	9	12	-	14.33
Watertown,	158	76	81	1	17	29	6	1	3	-	-	4	1	5	9	11	14	29	28	18	-	12.46
Webster,	137	68	69	-	12	40	5	2	1	1	-	3	4	8	9	6	18	22	12	6	-	12.33
Wellesley,	55	21	34	-	3	7	1	-	2	-	2	1	-	2	4	3	4	11	8	10	-	7.77
Westborough,[1]	147	85	62	-	4	3	1	1	2	1	2	-	3	8	14	13	22	24	38	15	-	10.04[2]
Westfield,	247	128	119	-	19	71	7	3	2	2	3	5	4	13	10	16	21	28	37	25	-	16.75
West Springfield,	120	59	60	1	8	24	7	2	3	-	2	5	1	6	12	9	15	8	18	8	-	13.48
Weymouth,	180	99	81	-	14	18	5	2	1	-	6	1	6	8	18	7	21	28	42	17	-	15.25
Whitman,	84	56	27	1	7	10	-	-	1	-	-	1	3	2	3	4	10	24	21	4	1	12.33
Williamstown,	68	40	28	-	5	10	-	-	-	-	-	-	1	1	4	7	8	15	15	7	-	15.35
Winchendon,	83	45	38	-	13	15	6	1	-	-	1	1	1	7	7	5	6	10	8	15	-	12.42
Winchester,	73	37	36	-	6	11	1	-	-	1	2	1	4	1	4	3	4	6	19	16	-	8.08
Winthrop,	119	60	59	-	7	14	1	3	-	-	1	-	2	16	11	11	10	22	19	9	-	15.24
Woburn,	217	116	101	-	10	29	8	5	1	1	3	6	7	15	8	15	26	32	33	28	-	14.94
Worcester,[3]	2,210	1,127	1,082	1	149	451	56	27	17	10	36	36	48	147	185	170	248	342	267	170	-	14.57[2]
	43,929	22,515	21,405	9	3,007	9,498	1,705	763	457	345	895	630	867	2,789	3,601	3,881	4,549	5,607	5,216	3,107	19	15.92

[1] Insane Asylum, 93, included. [2] In obtaining this death-rate, deaths occurring in public institutions were not included, many being non-residents.
[3] Insane Hospital and Insane Asylum, 221, included.

TABLE III.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each, 1909.

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Abington,	7	-	-	-	-	-	2	2	-	1	-	-	-	2	-	12	2	21	10	9	5	-	2	-	13
Adams,	22	-	1	4	5	2	1	-	1	-	4	-	9	-	-	18	2	27	13	6	4	2	6	-	53
Amesbury,	12	-	-	-	1	-	1	-	-	2	-	-	1	-	4	18	4	40	4	10	14	1	14	-	32
Amherst,	5	-	1	-	-	-	1	-	-	-	-	-	-	-	-	5	1	14	8	7	13	-	2	-	19
Andover,	7	-	-	-	-	1	1	-	1	-	-	-	3	-	3	6	1	14	10	9	6	1	5	-	28
Arlington,	15	-	-	-	1	1	3	-	1	-	-	-	2	-	1	14	9	23	8	9	7	1	7	-	54
Athol,	7	-	-	-	2	-	1	-	-	1	-	-	-	-	-	23	1	16	17	5	4	1	2	-	43
Attleborough,	11	-	-	-	3	-	1	-	-	1	3	-	8	-	3	10	3	16	15	16	13	1	6	-	79
Beverly,	20	-	-	-	2	2	1	3	-	-	1	-	21	14	-	27	5	36	21	21	22	1	5	2	80
Blackstone,	12	-	-	-	3	-	1	-	-	-	-	-	1	1	-	7	2	6	8	12	6	1	3	-	13
Boston,	1,072	1	73	82	193	74	91	31	54	32	62	2	633	14	117	1,262	168	1,242	946	682	670	124	620	127	2,651
Braintree,	8	-	2	-	-	-	1	-	-	-	-	-	2	-	1	8	1	14	19	6	7	3	1	-	30
Bridgewater,	11	-	-	-	-	1	-	3	-	1	1	-	-	1	4	7	-	11	6	8	5	1	1	13	20
Brockton,	48	-	8	6	3	6	5	1	4	11	1	-	11	11	9	46	11	77	33	44	44	9	14	1	220
Brookline,	15	-	-	1	2	-	3	3	-	-	1	-	1	-	1	34	7	69	25	28	37	3	3	-	73

TABLE III. — *Continued.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Cambridge, ...	151	–	3	14	21	7	10	3	7	1	6	1	102	2	11	155	41	190	178	71	58	7	9	11	484
Chelsea, ...	43	–	–	2	8	2	5	2	2	4	3	1	7	–	4	57	7	69	32	21	38	3	13	12	189
Chicopee, ...	33	–	1	2	8	3	1	–	2	1	–	–	15	3	5	54	15	33	19	12	11	–	15	–	161
Clinton, ...	13	–	–	–	2	2	2	–	–	–	1	–	3	–	3	19	4	9	2	13	9	2	5	–	102
Concord, ...	6	–	–	–	–	–	–	–	1	–	–	–	–	–	–	8	2	4	4	2	6	2	1	–	17
Danvers, ...	9	–	–	–	1	–	2	3	–	–	2	–	–	2	1	12	2	31	19	4	15	–	5	–	26
Dedham, ...	8	–	–	–	1	–	–	1	–	–	–	–	–	1	2	6	2	19	8	8	6	–	11	–	24
Easthampton, . .	7	–	–	1	3	2	–	3	–	–	–	–	3	–	1	9	6	11	3	1	7	2	5	–	46
Everett, ...	35	–	1	4	7	4	–	1	1	–	3	–	3	–	1	40	5	60	9	25	31	2	22	–	137
Fall River, ...	147	–	1	5	50	7	30	4	8	–	36	–	285	–	76	127	117	89	237	53	39	–	43	12	600
Fitchburg, ...	23	–	5	4	11	2	3	1	1	–	2	–	5	1	5	46	14	53	46	11	26	6	16	10	180
Framingham, . .	15	–	5	–	2	1	2	–	–	1	–	–	2	–	–	31	1	18	21	7	10	1	6	–	87
Franklin, ...	5	–	–	2	–	–	–	–	–	–	1	–	2	–	–	6	2	11	10	2	–	1	6	–	27
Gardner, ...	23	–	1	1	3	–	3	–	1	–	–	–	4	–	1	17	3	24	17	13	4	1	8	–	79
Gloucester, . . .	33	–	3	–	3	3	–	1	–	–	–	–	8	1	–	25	3	17	–	14	14	1	10	–	190
Grafton, ...	10	–	–	–	2	2	1	2	–	–	–	–	4	–	4	8	3	8	8	4	4	–	4	–	55
Great Barrington, .	2	–	2	–	–	–	1	–	1	–	–	–	3	–	–	9	–	13	6	5	4	–	3	–	33

Greenfield, . . .	4	-	-	-	-	-	1	-	1	1	-	-	1	-	-	10	-	12	11	10	8	-	6	8	47
Haverhill, . . .	54	-	2	1	14	5	2	2	1	-	5	-	27	-	2	65	8	72	35	51	32	9	22	1	212
Hingham, . . .	-	-	-	-	-	1	-	1	-	-	2	-	-	1	-	2	2	18	-	2	3	-	2	-	47
Holyoke, . . .	81	-	3	2	11	4	8	4	5	3	3	-	67	2	5	67	6	68	89	76	36	10	19	-	423
Hudson, . . .	6	-	-	-	-	1	-	1	-	-	-	-	3	1	1	3	2	12	4	7	7	-	-	-	18
Hyde Park, . . .	12	-	1	-	1	2	1	6	-	-	4	-	5	-	10	13	1	27	17	5	13	1	11	6	37
Ipswich, . . .	5	-	-	-	1	-	1	-	1	-	-	-	3	3	3	15	3	13	9	6	7	-	6	5	15
Lawrence, . . .	154	-	20	6	28	5	18	1	4	13	1	-	114	2	6	187	39	100	103	53	38	9	57	77	388
Leominster, . . .	16	-	1	-	3	1	-	1	-	2	2	-	12	5	1	32	-	28	49	17	21	4	9	3	71
Lowell, . . .	159	-	4	9	34	6	11	5	4	4	2	3	64	11	152	183	85	198	183	90	71	18	70	4	514
Lynn, . . .	97	-	1	7	26	6	9	4	2	4	5	-	24	2	-	119	17	132	164	87	74	8	34	-	374
Malden, . . .	44	-	-	3	7	2	6	-	2	1	-	-	6	-	1	66	4	77	56	30	40	2	17	-	163
Marblehead, . . .	5	-	-	-	1	2	2	-	1	-	-	-	2	2	-	21	3	25	-	6	9	3	-	-	43
Marlborough, . .	10	-	-	1	8	1	3	1	-	-	-	-	8	-	1	24	9	36	21	10	11	2	1	-	74
Maynard, . . .	6	-	-	-	-	1	-	2	-	-	-	-	15	3	1	14	3	10	4	1	5	-	1	-	18
Medford, . . .	23	-	-	4	3	-	1	-	-	-	-	1	-	1	-	29	6	30	-	22	18	1	5	-	129
Melrose, . . .	17	-	1	1	-	-	3	-	3	-	1	1	-	-	3	21	8	33	31	16	15	2	8	1	44
Methuen, . . .	17	-	-	1	2	-	3	9	-	1	1	-	9	1	4	18	7	17	7	1	7	2	6	3	74
Middleborough, . .	4	-	-	-	2	-	1	1	-	-	-	1	3	-	-	10	4	19	3	1	3	1	6	1	60
Milford, . . .	20	-	-	4	2	1	1	4	-	-	-	-	1	4	3	23	2	15	-	14	12	-	6	-	81
Milton, . . .	7	-	-	4	2	-	-	1	-	-	-	1	2	-	-	4	2	4	-	2	2	-	5	-	55
Montague, . . .	5	-	-	2	-	-	-	1	1	-	1	-	1	-	3	15	1	17	2	-	2	-	4	-	65
Natick, . . .	15	-	-	1	-	-	1	-	-	-	2	-	-	1	2	16	4	21	33	11	1	1	7	-	34

TABLE III. — *Continued.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
New Bedford,	122	–	1	7	15	8	20	7	4	–	4	–	75	5	6	187	65	142	59	73	46	5	19	–	724
Newburyport,	28	–	–	–	4	–	2	5	–	–	–	–	5	–	1	35	8	23	–	8	18	2	7	1	113
Newton,	25	–	3	3	7	–	3	3	2	–	1	–	3	–	12	41	9	40	44	13	24	1	15	17	176
North Adams,	28	–	–	–	1	3	6	1	1	–	3	–	12	1	1	33	6	29	1	18	19	4	10	–	188
Northampton,	22	–	–	–	2	1	–	3	2	–	2	–	5	1	4	22	5	51	69	17	22	4	10	9	83
North Attleborough,	12	–	–	–	1	1	–	1	–	–	1	–	6	–	4	15	1	10	22	6	11	1	5	–	32
Northbridge,	9	–	–	–	2	1	1	7	–	–	–	–	9	–	1	20	–	22	3	7	3	–	8	–	42
Norwood,	7	–	2	–	3	–	2	–	–	1	–	–	5	–	5	9	5	16	8	5	2	1	2	–	8
Orange,	6	–	–	–	–	–	–	5	–	–	–	–	–	–	1	9	2	16	9	6	4	–	3	–	14
Palmer,	6	–	1	–	8	2	1	5	–	–	–	–	21	1	1	14	2	15	11	3	5	1	8	6	9
Peabody,	8	–	–	–	4	2	9	–	1	1	1	–	10	3	2	21	7	40	22	20	7	1	6	–	59
Pittsfield,	41	–	1	1	3	–	8	12	–	–	–	–	8	–	12	64	9	58	39	24	22	–	29	–	115
Plymouth,	15	–	1	1	3	–	2	7	–	–	–	–	4	7	1	23	7	30	22	9	15	2	5	1	55
Quincy,	45	–	1	–	2	4	3	3	–	–	–	–	–	4	23	32	3	72	32	20	18	3	31	28	67
Reading,	3	–	1	1	1	–	1	1	–	–	–	–	–	–	–	8	2	6	7	2	1	1	2	–	36
Revere,	13	–	2	–	3	2	2	1	1	1	–	–	5	–	4	27	4	26	9	13	10	4	13	–	100
Rockland,	14	–	–	–	–	–	–	–	–	–	–	–	–	2	3	2	2	14	–	5	11	–	3	–	38
Salem,	41	–	1	1	5	5	1	1	1	–	4	–	33	11	4	86	12	75	49	45	36	8	33	–	243

Saugus,	11	-	-	-	1	-	2	-	-	-	-	-	1	-	-	12	4	15	1	3	3	3	6	-	53
Somerville,	77	-	3	9	27	3	8	4	1	-	8	-	13	3	5	113	25	112	74	104	83	5	30	-	280
Southbridge,	12	-	-	-	5	2	5	-	-	-	-	-	6	7	3	23	1	13	18	10	11	-	3	9	35
South Hadley,	6	-	1	-	-	-	1	-	-	1	1	-	-	1	-	4	-	8	6	2	1	-	3	-	21
Spencer,	5	-	-	-	-	-	1	1	-	-	-	-	1	1	-	3	5	13	-	4	5	-	3	-	64
Springfield,	88	-	7	24	33	3	11	1	9	6	10	-	28	2	40	151	20	90	40	156	65	15	44	14	451
Stoneham,	9	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4	3	21	15	12	12	2	2	-	25
Stoughton,	7	-	-	-	-	-	1	4	-	-	4	-	1	-	-	7	4	6	2	8	5	-	3	-	44
Swampscott,	12	-	-	-	2	-	-	1	-	-	-	-	-	-	-	3	3	11	2	4	2	2	2	2	15
Taunton,	51	-	2	4	3	7	12	-	1	3	6	-	10	6	68	64	24	38	71	25	23	1	7	-	289
Wakefield,	16	-	-	1	-	2	1	-	-	-	1	-	2	1	1	10	4	20	18	3	6	1	2	-	38
Waltham,	28	-	2	5	3	-	6	-	1	-	7	-	3	-	-	60	3	48	11	-	14	2	16	12	171
Ware,	16	-	-	-	-	1	-	4	2	-	-	-	12	5	1	13	3	12	13	12	3	-	2	1	27
Watertown,	13	-	1	-	-	2	-	-	-	-	-	-	1	-	-	23	2	15	12	4	6	3	5	-	70
Webster,	17	-	-	1	-	2	1	1	-	-	1	-	8	-	14	12	-	7	10	12	9	-	4	1	37
Wellesley,	2	-	-	1	-	1	-	-	1	-	-	-	-	-	-	6	3	16	-	5	1	1	1	-	17
Westborough,	11	-	3	1	-	1	-	-	-	-	-	-	1	1	-	38	1	18	52	7	5	-	5	-	3
Westfield,	14	-	-	-	2	4	2	1	-	-	2	-	3	-	-	36	2	30	12	12	9	1	15	-	102
West Springfield,	7	-	-	-	2	1	1	4	1	-	4	1	7	1	-	14	2	9	9	8	5	3	10	1	30
Weymouth,	18	-	1	1	4	5	1	1	-	-	1	-	1	-	-	17	4	32	23	12	9	1	7	4	37
Whitman,	8	-	-	-	1	1	-	1	-	-	-	-	1	1	-	3	1	15	12	8	5	-	1	-	26
Williamstown,	4	-	-	-	-	1	-	-	-	-	-	-	-	2	-	13	1	4	6	2	4	1	1	-	28
Winchendon,	10	-	-	-	-	-	-	4	1	1	-	-	-	2	-	11	-	9	9	2	2	3	6	-	23
Winchester,	4	-	-	-	-	-	-	-	-	-	1	-	1	-	2	10	1	11	13	4	6	-	3	-	16

TABLE III. — *Concluded.*

	Consumption.	Smallpox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping Cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Winthrop,	5	-	1	1	-	-	1	-	1	2	-	-	2	2	1	11	3	20	17	7	17	3	4	7	14
Woburn,	29	-	-	-	3	-	1	-	1	-	-	-	2	2	-	22	-	27	5	11	10	-	6	2	96
Worcester,	172	-	7	8	22	28	12	28	12	2	3	2	173	-	22	228	27	209	285	85	130	10	88	4	653
	3,693	1	182	244	654	253	373	225	153	103	221	14	1,983	166	697	4,642	955	4,783	3,725	2,472	2,299	345	1,663	416	13,598

	Homicide.
Abington,	1
Boston,	30
Braintree,	1
Brockton,	2
Cambridge,	4
Haverhill,	3
Lawrence,	1
Leominster,	1
Lynn,	1
Maynard,	1
Newton,	1
Northampton,	1
Norwood,	1
Peabody,	1
Quincy,	2
Springfield,	1
Waltham,	1
Watertown,	1
Weymouth,	1
Winchester,	1
	56

	Actinomycosis
Boston,	1

	Hydrophobia.
Boston,	3
Lowell,	1
Lynn,	1
	5

	Malignant Pustule.
Lynn,	1
Williamstown,	1
	2

	Glanders.
Somerville,	1

	Tetanus.
Arlington,	1
Greenfield,	2
Quincy,	1
	4

Table IV.

Deaths from Specified Causes, 1909, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1905–09), Deaths per 1,000 from All Causes, 1905–09.

Causes of Death.	Deaths 1909.	Mortality per 10,000 of the Population.					Deaths per 1,000 from All Causes.				
		1909	1908	1907	1906	1905	1909	1908	1907	1906	1905
Consumption, . .	3,693	13.38	13.49	15.50	15.11	16.01	84.07	82.20	88.75	91.00	95.46
Smallpox, . . .	1	0.0036	0.02	0.01	–	0.008	0.022	0.13	0.09	–	0.046
Measles, . . .	182	0.66	1.22	0.55	0.58	0.61	4.14	7.43	3.13	3.49	3.62
Scarlet fever, . .	244	0.88	1.15	1.00	0.43	0.43	5.55	7.02	5.72	2.60	2.56
Diphtheria and croup, .	654	2.37	2.45	2.61	2.50	2.20	14.89	14.95	14.90	15.03	13.13
Whooping cough, . .	253	0.92	1.01	0.81	1.72	0.64	5.76	6.13	4.65	10.35	3.78
Typhoid fever, . .	373	1.35	1.76	1.25	1.64	1.87	8.49	10.76	7.14	9.87	11.15
Cerebro-spinal meningitis.	225	0.82	0.93	1.98	1.78	2.36	5.12	5.68	11.36	10.71	14.10
Erysipelas, . . .	153	0.55	0.40	0.49	0.43	0.52	3.48	2.45	2.81	2.58	3.11
Puerperal fever, . .	103	0.37	0.33	0.39	0.28	0.34	2.34	2.02	2.23	1.71	2.00
Influenza, . . .	221	0.80	1.04	1.56	0.51	1.22	5.03	6.33	8.91	3.08	7.26
Malarial fever, . .	14	0.05	0.03	0.08	0.06	0.13	0.32	0.16	0.47	0.36	0.78
Cholera infantum, .	1,983	7.19	7.08	5.71	5.59	5.88	45.14	43.18	32.67	33.70	35.05
Dysentery, . . .	166	0.60	0.53	0.53	0.58	0.62	3.78	3.21	3.04	3.49	3.71
Diarrhœa and cholera morbus.	697	2.53	3.07	4.73	4.10	4.15	15.87	18.70	27.06	24.72	24.74
Pneumonia, . . .	4,642	16.82	16.88	17.98	17.72	17.75	105.67	102.94	102.98	106.72	105.85
Bronchitis, . . .	955	3.46	3.63	4.31	4.19	4.31	21.74	22.16	24.68	25.27	25.69
Diseases of the heart, .	4,783	17.33	17.36	18.43	17.00	17.36	108.88	105.84	105.52	102.40	103.50
Diseases of the brain and spinal cord.	3,725	13.50	14.03	14.10	12.46	14.74	84.79	85.57	80.72	75.03	87.88
Diseases of the kidneys,	2,472	8.96	8.46	9.15	8.95	9.01	56.27	51.58	52.38	53.90	53.75
Cancer, ...	2,299	8.33	8.47	8.37	8.13	7.97	52.33	51.64	47.93	48.98	47.55
Suicide, . . .	345	1.25	1.36	1.35	1.00	1.09	7.85	8.29	7.74	6.01	6.52
Accident, . . .	1,663	6.03	6.37	7.19	6.29	5.88	37.86	38.82	41.16	37.87	35.06
Unknown or ill-defined causes.	416	1.51	2.79	2.15	1.98	2.00	9.47	17.02	12.30	11.95	11.96
All causes, . .	43,929	159.17	164.00	174.65	166.10	167.67	–	–	–	–	–

HEALTH OF THE STATE.

Third Annual Report upon the Work of the State Inspectors of Health.

By the Assistant to the Secretary of the Board.

Owing to several new legislative provisions, the routine work of the State Inspectors of Health has been considerably modified. When in 1907 the State was divided into fifteen health districts, and one physician was appointed State Inspector of Health in each district, the inspection of slaughterhouses and provisions did not fall within the province of the inspectors, whose duties at the outset were varied and extensive along three distinct lines of work, namely: (*a*) watching the incidence of tuberculosis and other communicable diseases, inquiring into their causes, and assisting local health authorities to take the best possible preventive measures for the safety of the public; (*b*) keeping an eye on all young persons employed in factories, and examining them as to their health; and (*c*) enforcing, under the direction of the State Board of Health, statutes relative to factory, tenement and school hygiene.

In the following year (1908), the State Board of Health and the State Inspectors of Health were specifically charged with certain duties relative to slaughtering and meat inspection, and in June of the present year the Legislature directed the State Board of Health to investigate the slaughtering of neat cattle, sheep and swine. This investigation occupied the State Inspectors of Health for a period averaging about two months. The report called for by the Legislature is contained in the general report for the State Board of Health, pages 1–5.

In the 1908 report mention was made of the difficulty of establishing routine procedures and of classifying the details of the work for certain purposes, chiefly, perhaps, because of the variety of duties to be performed. Yet, in spite of the interruption caused by the additional statute provisions referred to, the way became clear for the adoption of a scientific schedule consisting of fundamental principles upon which much of the future work relating to factory and occupational hygiene will depend.

As to data relating to the health of minors in factories, it was pointed

out last year that the discovery of all the minors who had any physical disability was highly improbable, and that it was doubtful whether, without further legislation, the percentage of minors in ill health could be determined with any degree of accuracy. By a recent act of the Legislature the word "minor," as used in all laws relating to the employment of labor, is defined as "a person under eighteen years of age." With this change in legislation, approximately half the number of young persons formerly grouped as minors could no longer be considered such, and it was thought, consequently, that those boys and girls found to be between the ages of fourteen and eighteen years would receive more attention, and that better results would be obtained. While in a measure this proved to be the case, the absence of suitable places for the examination of young persons has proved a serious handicap in the work. Obviously, it is important to gather certain information concerning the health of young persons in factories *at their work,* and in connection therewith to study the influence of occupation upon health. But without better conveniences for making physical examinations, the work cannot be done properly. Moreover, the examinations of young persons ought to take into account and to record among other things *fitness for the particular kind of work done,* and ought to be made with sufficient frequency, which in any trade or process should not be less often than once a year, and in some occupations or processes not less often than twice or three times a year. Under existing conditions, however, so thorough a system can be only partially carried out.

The principles upon which the study of factory and occupational hygiene is to be based for the immediate future, and the manner of enforcing the existing laws on factory sanitation, may be understood from the following outline: —

Whenever a State Inspector of Health finds in a factory or workshop in which five or more women or young persons are employed (*a*) inadequate ventilation, (*b*) ineffective means for the removal of dust (irritating or poisonous dust, including infective matter), (*c*) gases, fumes and vapors (irritating, poisonous or offensive), he sends a written notice to the employer in the form of an order for adequate means of ventilation and removal of dust, gases, etc., which order must be complied with within a period of four weeks.

Whenever a State Inspector of Health finds that employees in any factory or workshop are not sufficiently protected against dust from emery wheels or belts, or buffing wheels or belts, he issues a written order for such suction pipes and connections as he shall approve.

Whenever a State Inspector of Health finds employees in textile factories exposed to (*a*) impure or foul odors from water used for humid-

ifying purposes, or to (*b*) an excess of artificial moisture, he issues a written order to the effect that water used for humidifying purposes shall be of such a degree of purity as not to give rise to impure or foul odors, and shall be so used as not to be injurious to the health of persons employed in such factories.

Among other conditions or influences to which an occupation of special hygienic interest may involve exposure are (1) lack of cleanliness, (2) poor or insufficient light, (3) dampness, aside from artificial moisture in the textile industry, and (4) excessive heat. Inasmuch as there is no legal standard of cleanliness in a factory or workshop, the State Inspectors of Health have in mind the highest standard of cleanliness found to exist in the best factories and workshops carrying on similar business in similar buildings within the Commonwealth. If it appears to a State Inspector of Health that this standard is not lived up to, he sends a notice to the employer in writing, either in the form of an order or a recommendation based upon a general statute requirement that all factories and workshops shall be kept clean. In the same way, whenever such provision is *not* made for light, either by daylight or by artificial light, that, in the opinion of the State Inspector of Health, the persons employed in a factory or workshop shall not be in danger of injury to their eyesight, a written order or recommendation is sent to the employer to the effect that better light must be provided. In cases when good light is less essential, owing to the kind of work done, and poor light will not probably lead to injury, although the effect of well-lighted rooms is desirable as a concomitant factor in the maintenance of health, a State Inspector of Health offers such suggestions in writing to the employer as he deems proper.

Owing to the fact that there is no specific statute relative to overcrowding in a factory or workshop, State Inspectors of Health are instructed when the number of cubic feet of space in any room bears to the number of persons employed at a time in the room a proportion less than three hundred, and the factory is impossible of proper ventilation without an expensive mechanical system, to make such recommendations in writing to the employer as in his judgment are necessary.

Whenever employees in factories or workshops are exposed to indoor dampness or to excessive heat, provided either condition is to a certain extent avoidable, State Inspectors of Health make such suggestions in writing to the employer as appear advisable.

In addition to the above-mentioned conditions or influences to which the occupation involves exposure, the Massachusetts laws require that pure drinking water shall be provided for employees in manufacturing establishments, that medical and surgical appliances be provided in fac-

tories, that seats for women employees be provided in manufacturing, mechanical or mercantile establishments, that washing facilities be provided in foundries, and that receptacles for expectoration be provided in all factories and workshops.

Aside from the legal aspect of the subject, the investigations are so made and reported as to show (1) the conditions necessary from a commercial point of view, and (2) the hygienic conditions or influences from the point of view of the health of (*a*) young persons and (*b*) adults.

By a statute provision in force October 1 of the current year, State Inspectors of Health no longer have authority to order "further or different sanitary or ventilating provisions in schoolhouses." As the law now stands, three sets of officials, one local and two State, are authorized to examine school buildings, while one State department, the District Police, may "order such structural or other changes in said buildings[1] as are necessary relative to the construction, occupation, heating, ventilating and the sanitary conditions and appliances of the same." School physicians are required to make such an examination of school buildings as in their opinion, and State Inspectors of Health as in the opinion of the State Board of Health, "the protection of the health of the pupils may require," although the functions of all these health officials are solely advisory.

For the sake of clearness, the following definitions of words and phrases used in the report are given: —

Local Nuisances. — By "nuisances" is meant public nuisances, that is, objectionable conditions which affect the public or the community.

Factory and Occupational Hygiene. — By "factory hygiene" is meant a study of the sanitary conditions in the factories. Under this heading are given numerical or other data obtained while inspecting factories.

By "occupational hygiene" is meant a study of the influence of occupation, trade, process of manufacture, or any particular method of carrying on such occupation, trade or process of manufacture, upon health.

Tenement Hygiene. — "Tenement hygiene," or "hygiene of tenement workrooms," relates to the manufacture of clothing in tenements and dwellings, and includes the labeling of tenement-made clothing and the inspection of clothing made in improper places or under unhealthy conditions.

Diseases Dangerous to the Public Health. — By "diseases dangerous to the public health" is meant those infectious diseases which the State Board of Health has declared to be "dangerous to the public health,"

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[1] Probably through inadvertence, the phrase "except in the city of Boston" was omitted in Section 105, chapter 514 of the Acts of 1909 (*cf.* chapter 354 of the Acts of 1909).

and which are therefore notifiable under the provisions of sections 49 and 50 of chapter 75 of the Revised Laws.

In order that each State Inspector of Health might be informed as promptly as possible of the existence of diseases dangerous to the public health within his district, the boards of health of the cities and the larger towns were supplied with double postal cards, containing the following printed forms, one card addressed to the State Inspector of Health, the other to the State Board of Health. Cards for reporting cases of infectious diseases to the State Board of Health have long been in use, in accordance with statutory provisions, but cards for reporting to each State Inspector of Health the number of cases of such diseases as may occur within his district have only recently been extensively adopted by local authorities, at the suggestion of the State Inspectors of Health. By this means it is now possible for the State Inspectors of Health to follow the incidence of communicable diseases, in order to inquire into the causes of the diseases and to suggest practical preventive measures to prevent their spread.

REPORT OF INFECTIOUS DISEASES TO THE STATE BOARD OF HEALTH.

As required by the provisions of Chapter 75, Section 52, Revised Laws.

Cases reported on ____________________ , *to the Board of Health of* ____________________

DISEASE	NAME	ADDRESS

Signature of Sec'y or Agent of Board of Health ____________________

REPORT OF INFECTIOUS DISEASES TO THE STATE INSPECTOR OF HEALTH.

Cases reported on ______________ *, to the Board of Health of* ______________

Diseases	No. of Cases	Diseases	No. of Cases
Actinomycosis, ...		Smallpox, ...	
Anterior Poliomyelitis, . .		Tetanus, ...	
Asiatic Cholera, . . .		Trachoma, ...	
Cerebro-Spinal Meningitis, .		Trichinosis, ...	
Diphtheria, ...		Tuberculosis, ...	
Glanders, ...		Typhoid Fever, ...	
Leprosy, ...		Typhus Fever, ...	
Malignant Pustule, . . .		Varicella, ...	
Measles, ...		Whooping Cough, . . .	
Ophthalmia Neonatorum, .		Yellow Fever, ...	
Scarlet Fever, ...			

Signature of Sec'y or Agent of Board of Health ______________

During the year the State Inspectors of Health distributed to local boards of health, visiting nurses, charitable organizations, superintendents of schools, factory employers and employees, anti-tuberculosis societies, and others, several thousand copies of the pamphlet prepared by the State Board of Health "On the Prevention of the Spread of Tuberculosis," the pamphlet having been arranged particularly for the needs of Massachusetts.

Following is a record of the proceedings and observations of the State Inspectors of Health for the fiscal year ending Oct. 31, 1909, in accordance with the provisions of section 4 of chapter 537 of the Acts of 1907.

Health District No. 1.

Charles E. Morse, M.D., *Wareham, State Inspector of Health.*

This district includes the counties of Barnstable, Dukes and Nantucket, and the town of Wareham.

Diseases Dangerous to the Public Health.

Local health authorities have done much better work in connection with the prevention of the spread of tuberculosis, both in making inquiries, and, when necessary, visiting persons ill with the disease as soon as notice of the illness was received, and in the matter of inspecting and fumigating premises after occupancy by patients. While the State Inspector of Health reported

that in his opinion more cases of tuberculosis were revealed to local health authorities than in former years, some physicians are still refusing to report such cases.

Eight cases of diptheria scattered throughout the district were reported. Some advance was made on the part of a few towns in the method of quarantine by demanding at least one negative culture before releasing the patient.

An extensive epidemic of measles occurred in Barnstable during May, June and the first half of July, — 74 cases in all. During November and December, 1908, 58 cases of this disease were reported.

Local Nuisances.

Three alleged nuisances were investigated as follows: relative to two tenement houses and their surroundings in Provincetown; a barn cellar in Harwich where pigs were kept; and relative to the draining of numerous cesspools and sink drains into Eel Pond, Wood's Hole, Falmouth. In each instance it was found that a nuisance existed, and the State Inspector of Health informed the local board of health that they had absolute power to abate the same. The conditions in two of the towns were much improved.

Consultations with Local Boards of Health.

In Oak Bluffs, Provincetown and Wareham the local health authorities gave considerable attention to the improvement of existing conditions on milk farms. While no attempt was made to introduce the practice of bacterial counts, or to establish any definite standard of cleanliness, an honest effort was made to keep the cows, barns and surroundings reasonably clean. The State Inspector of Health urged the importance of dairy sanitation upon all the local authorities within the district.

Schoolhouse Hygiene.

During the spring 12 schoolhouses in the town of Wareham were inspected and detailed reports of the conditions found were filed in the office of the State Board of Health.

Four of the school buildings were found, in the opinion of the inspector, totally unfit for use. Considering the conditions of the buildings, the structural changes that would be necessary to render them suitable would involve an unreasonable expenditure of money.

In 1 school building it appeared to the State Inspector of Health that an adequate heating and ventilating system might be installed at a moderate cost which would make the building reasonably safe for a small number of pupils.

A tendency to overcrowd certain rooms was noticed in a number of school buildings. In 4 schools the overcrowding of some of the classes was such as to be decidedly objectionable.

In 4 schools the arrangement of the desks with relation to the windows was bad, inasmuch as it caused the pupils to face the light. In 1 schoolhouse the light could be materially improved by whitening the walls and ceilings and cleaning the windows.

The cleanliness of 2 buildings was not satisfactory, and in 1 school it was observed that some of the larger pupils could not sit properly in their seats, since the desks were not high enough to allow the knees to go under.

In 1 schoolhouse an auxiliary heater was found in the basement room where the toilet facilities were located. The air in this room was foul, and for this reason it appeared to the State Inspector of Health that in case the boards of which the cold-air duct was constructed should become loosened, a considerable supply of foul air might be supplied by means of the heater to the intermediate room. It appeared to the State Inspector of Health that the heater should be removed from its present location; furthermore, that modern plumbing be provided, that small cesspools for waste water from taps be constructed and that greater care should be taken as to the cleanliness of the building.

Slaughterhouse Inspection.

During the year each of the 28 slaughterhouses in the district was inspected. Some towns issued no licenses, some appointed no meat inspectors, and some failed entirely to observe the laws. Persons appointed as meat inspectors in some towns did not make it a practice to be present at the time of slaughter. In one town the meat inspector's stamp was found to be kept by the proprietor of a slaughterhouse. Consultations were held with the selectmen and boards of health of the various towns in relation to the slaughtering laws, and before the end of the year the State Inspector of Health believed that the laws relating to licenses for slaughtering, inspection of meat and stamping carcasses were observed and enforced in each town. In the opinion of the State Inspector of Health, local health authorities might do much to make the conditions of slaughterhouses better by frequent inspections and by demanding strict cleanliness of buildings and surroundings.

Health District No. 2.

Adam S. MacKnight, M.D., *Fall River, State Inspector of Health.*

This district includes the cities of Fall River and New Bedford, and the towns of Acushnet, Berkley, Dartmouth, Dighton, Fairhaven, Freetown, Marion, Mattapoisett, Rehoboth, Rochester, Seekonk, Somerset, Swansea and Westport.

Diseases Dangerous to the Public Health.

In an investigation of the prevalence of typhoid fever during the month of August, the State Inspector of Health inspected the milk routes of a dealer in Fall River whose entire supply came from without the State, in addition to the routes of other dealers who were accustomed to exchange

receptacles; also small stores and various milk farms and home conditions under which milk was received. The total number of milk farms visited in adjoining towns within and without the State was 75. One hundred and forty-one tenement houses, 26 stores and 15 other establishments were inspected. While no definite cause for the outbreak of the disease could be determined, many unhygienic conditions were revealed and remedied.

Consultations with Local Boards of Health.

During the investigation of local nuisances, the chairman or some member of the local board of health not infrequently has accompanied the State Inspector of Health. In this way the State Inspector of Health has become well acquainted with many health officials within his district, and is better able to deal with them in matters which tend to affect the public health. Especially valuable results have been obtained in dealing with the local authorities in the smaller communities in relation to preventing the spread of diseases dangerous to the public health. The city boards of health have acted promptly in making quarantine regulations.

In the town of Marion (population 1,029) the local board of health was found to be doing little, if anything, beyond placarding houses and notifying school authorities whenever a case of communicable disease was known to exist. Such matters as those relating to the establishment of quarantine were left entirely in the hands of the local physicians. The most of the physicians reported cases of scarlet fever, diphtheria and measles, although not because of any request of the board of health. Practically nothing had been done to prevent the spread of tuberculosis. The State Inspector of Health informed the local board of health that when a physician diagnosed a case of diphtheria the State would supply antitoxin in necessary quantities, and that when a person was discovered with cough and expectoration that had lasted for some time, boxes for expectoration would be furnished for a bacteriological examination, which would confirm or tend to eliminate the diagnosis of tuberculosis.

In the town of Fairhaven (population 4,235) the State Inspector of Health found that the local board of health had not notified the practicing physicians of the town of the diseases declared by the State Board of Health on Aug. 1, 1907, to be dangerous to the public health, and that, consequently, few physicians reported such cases. When such diseases as scarlet fever, diphtheria and measles were reported by physicians the local board of health notified the library authorities. Matters relating to quarantine were found to be left with the attending physicians, each one determining for himself and his patient the necessary period of quarantine.

Many matters of minor importance were attended to by the town improvement society without the assistance of the local board of health. This board, likewise, was informed that culture tubes, diphtheria antitoxin and sputum boxes would be supplied by the State when needed.

In reply to questions asked by the local board of health relative to water supplies and sewerage the State Inspector of Health advised that wherever

possible wells should be discontinued and connections should be made with the town water supply, and that cesspools should be connected with the sewerage system.

Health of Minors in Factories.

The total number of minors seen and questioned was 1,581.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	84	93	109	117	123	139	154	819
Female,	79	81	97	105	122	137	141	762
Total,	163	174	206	222	245	276	295	1,581

No minors were found to be in ill health.

Schoolhouse Hygiene.

With but few exceptions the school buildings in the cities within the district were found to be modern in construction and equipment and to have conditions favorable to the health of the pupils, so that the attention of the State Inspector of Health was directed mainly to the schoolhouses in the smaller communities. With the exception of one town the schoolhouses in the various towns were not free from criticism. In many instances the buildings were totally unfitted for school purposes, being in need of repair, improperly heated, inadequately ventilated and poorly equipped, — conditions which are not conducive to the physical welfare of school children.

Westport. — With the exception of the 2 new school buildings at Westport Head and Westport Point, respectively, the schoolhouses were found to be old, without cellars, with but one room and in an unsanitary condition. In the opinion of the State Inspector of Health some of the barns in the neighborhood were in better order and more comfortable than the buildings used for school purposes. The buildings equipped as they were could not be properly heated or ventilated. Pupils near a stove located on one side were subjected to excessive heat, while those remote from the stove were necessarily cold. Whatever ventilation was provided must be by opening the windows, with the result that some of the pupils were exposed to drafts. Proper washing facilities were lacking in all the buildings.

It was discovered that the privies and vaults were faulty in construction, seldom emptied and never disinfected.

Union Grammar and Primary School. — The building was found to be in bad condition generally, as, for example, plaster falling, floors in bad order, rooms dirty and faulty stove piping.

Lighting: While the schoolhouse was reasonably well lighted the light might be improved by whitening the walls and ceilings and by substituting larger windows for the present small ones.

Ventilation: The ventilation of each room was so inadequate that in order

to provide for efficient and proper ventilation structural alterations would be necessary involving an unreasonable expenditure of money in view of the building in question. The building was not kept clean, and in the opinion of the State Inspector of Health was totally unfit for school purposes.

South Westport School. — In general, the conditions were found to be unsuited for school purposes.

Ventilation: No ventilating provisions. In the opinion of the State Inspector of Health the only way of providing efficient and adequate ventilation would be by structural alterations which probably could not be made without unreasonable expense; hence the building was deemed unfit for school purposes.

East Side School. — Building generally neglected. In need of repair inside and out. Without proper ventilating provisions and should either be abandoned or rebuilt. Surroundings greatly neglected.

Horseneck School. — Building was found to be neglected inside and out, and in the opinion of the State Inspector of Health was totally unfit for school purposes.

Westport State Side School. — Building was found to be badly in need of repair inside and out. In the opinion of the State Inspector of Health it was totally unsuited for school purposes.

Hick's Corner School. — The building was found to be in need of repair generally. In the opinion of the State Inspector of Health its use should be discontinued for school purposes.

Mouse Mill School. — The building was found to be only in fair condition, and in the opinion of the State Inspector of Health the location was unsuited for a schoolhouse.

Westport Point Grammar and Primary School. — The State Inspector of Health approved both location and building for school purposes. Both ventilation and lighting appeared to be adequate, and the rooms were of modern size and equipment.

Head High, Grammar and Primary School. — The State Inspector of Health approved both location and building for school purposes.

Ventilation and Lighting: Ventilating and lighting provisions were adequate.

Sanitaries: The water-closet provisions were modern and satisfactory, although means were not provided for an adequate supply of water for flushing purposes. In other respects it was the best school building in the town.

Sanford Road School. — Lighting: While the room was fairly well lighted, the light might be improved by whitening the walls and ceilings, and by inserting larger windows.

Ventilation: The ventilation, aside from overcrowding, was distinctly bad. In the opinion of the State Inspector of Health the building was too small, and totally unfit for school purposes.

Acoaxet School. — While it appeared to the State Inspector of Health that the present location for a school building was necessary, it seemed to

him that the building needed to be reconstructed, particularly because of inadequate ventilation.

West Side School. — The schoolhouse was found to be in need of extensive repairs, inside and out. It was neither adequately ventilated nor well lighted, and in the opinion of the State Inspector of Health was unfit for school purposes.

Macomber's Corner School. — The building was found to be in need of repair, inadequately ventilated, overcrowded and poorly lighted, and while in the opinion of the State Inspector of Health it was not entirely unfit for school purposes, structural alterations were necessary which could only be made at considerable expense.

Brownell's Corner School. — The schoolhouse in general was found in an unsatisfactory condition. It was inadequately ventilated, overcrowded, not well lighted, and not kept clean, and in the opinion of the State Inspector of Health should be enlarged and improved or condemned.

North Westport School. — The building was found to be in need of repair and general improvement. Neither ventilating provisions nor water-closet provisions were adequate.

ACUSHNET. — *Long Plain School.* — The building was found to be greatly in need of repairs, inside and out. The rooms were not kept clean and the seats for the pupils were not proper. The walls, ceilings and stairways needed cleaning and repairing. The ventilating provisions were inadequate and the rooms were not well lighted. Provision was not made for a sufficient number of proper water-closets. Proper washing facilities were lacking.

Perry Hill School. — The building was found to be in need of repair. Both ventilation and light were inadequate and both could be improved with reasonable expense. Ceilings and walls needed whitening, and the desks for the pupils were unsuitable. Proper washing facilities were lacking.

Military Hygiene.

During the period between August 13 and August 20 various detachments of troops marched and camped within this district. The headquarters were at North Quittacus, Rochester. Landings were made at New Bedford and Fairhaven. Among the towns invaded were Mattapoisett, Marion, Rochester, Acushnet, Freetown and Berkley. During the period of the maneuvers the camping places were inspected daily by some health official, including observations made by the State Inspector of Health. The sanitary regulations of the army authorities were strict, and, in the main, effective, although several instances of bathing in the waters of lakes and ponds were noted. The latrines were sufficiently numerous, but lacked fly screens. Criticism might also be made as to the shallowness of the trenches, the insufficient use of chlorinated lime as a disinfectant, and not infrequent delays in the prompt covering of dejecta. During the same period the State Inspector of Health observed that some of the travelling public disregarded public health precautions, and consequently caused conditions far more dangerous to the camping communities by careless disposal of excreta than the maneuvering army.

Results of Slaughterhouse Investigation.

The following prosecutions were conducted for violating the slaughtering laws:—

The proprietor of a slaughterhouse in Seekonk pleaded guilty in the First District Court, Taunton, for conducting a slaughterhouse without a license and for slaughtering without a license, and was fined $5 on each count.

Two proprietors of slaughterhouses in Swansea pleaded guilty in the Second Bristol Court, Fall River, for (*a*) slaughtering on Sunday, a day not specified in the license; (*b*) failing to notify, and slaughtering a carcass in the absence of a meat inspector; (*c*) having in possession with intent to sell a carcass which had not been inspected and stamped; and (*d*) slaughtering without a license. In accordance with the custom of the court in first offences, the charges were filed on payment of costs, amounting to about $13.

Six proprietors of slaughterhouses in Dartmouth pleaded guilty in the Third District Court, New Bedford, for slaughtering without a license, and were fined from $10 to $15 each. The same men were fined from $10 to $15 for using a building for slaughtering purposes without the written consent and permission of the board of health. A case against a proprietor of another slaughterhouse was tried, for slaughtering cattle without causing carcasses to be inspected and for having in his possession with intent to sell a portion of a carcass not stamped or branded as provided by law. The defendant pleaded guilty, and the case was discharged on a technical ruling of the court.

Prosecution was conducted in the Second District Court, Fall River, for offering for sale as food a carcass which had not been inspected or stamped at the time of slaughter. The charges were filed, the defendants paying costs amounting to $3 and being discharged.

The investigation was continued until no unlawful slaughtering was detected. Fall River and New Bedford have appointed regular salaried meat inspectors. There was but one licensed slaughterhouse in each city although seven or eight licensed butchers slaughter in each building. In the towns most of the farmers insisted upon a place for slaughtering and the right to butcher at home, and succeeded in obtaining a license therefor. Such licenses invite patronage, and the premises are sublet to neighboring or out-of-town dealers or butchers. It is known that carcasses have been carried from one town or place of slaughter to another without either having been inspected or stamped. It is known, too, that carcasses have been stamped on highways by officials who have never seen the heads or internal organs, and that slaughtering has been conducted secretly at night, without official inspection or stamping, in remote sections, the products of which were taken to small stores in crowded localities in the early morning hours to meet the needs of the industrial population, or sold to foreigners conducting large boarding houses, for pickling, sausages or other food purposes.

Health District No. 3.

Wallace C. Keith, M.D., *Brockton, State Inspector of Health.*

This district includes Plymouth County, exclusive of the towns of Marion, Mattapoisett, Rochester and Wareham, and, in addition, the towns of Cohasset and Weymouth.

Diseases Dangerous to the Public Health.

Measles in Brockton. — In December, 1908, 6 cases of measles were reported; in January, 1909, 203; in February, 423; in March, 700; and in April, 369. The schools were closed from February 19 to March 8.

Typhoid Fever. — In late May and early June a series of cases of typhoid fever appeared in Brockton. The cause of the outbreak was thought to be due to an employee on a milk farm who himself was ill with the disease about the middle of May. Another series of typhoid cases occurred in Brockton during the latter part of August, September and October. There were several so-called walking typhoid cases, and it was found that the water used in the home of the first person stricken with the disease was from a badly polluted spring. The local board of health later forbade the use of this water for drinking purposes. Seven cases were found in one family. On the premises occupied by this family were the contents of an old cesspool, into which excreta of former typhoid patients had been put, some of which overflowed into the dark cellar.

Another outbreak of typhoid fever which occurred on a milk route was thought to be due to the illness of an employee, who remained several days on the farm ill with beginning typhoid.

Consultations with Local Boards of Health.

Considerable time was spent in interviews with local boards of health relative to the following matters: reporting cases of diseases dangerous to the public health; regulating quarantine; the statute provisions relative to meat inspection and the inspection of slaughterhouses; regulating garbage disposal and abating nuisances.

Local Nuisances.

In Plympton, a large amount of refuse from the rendering plant left exposed near several dwelling houses gave rise to a disagreeable odor. This nuisance was called to the attention of the local board of health by the State Inspector of Health, and abated.

In Rockland, the contents of a cesspool were overflowing into the cellar of a neighbor, thus constituting a nuisance. The matter was brought to the attention of the local board of health by the State Inspector of Health, and the nuisance abated.

In West Bridgewater, the hogs of one farmer were so near a neighbor's house as to be adjudged a nuisance by the State Inspector of Health, who reported the matter to the local board of health. The nuisance was abated.

In Middleborough, hogs under a barn in the thickly populated part of the town were offensive to the neighborhood. The State Inspector of Health, after investigating, brought the matter to the attention of the local board of health, and the nuisance was abated.

In Weymouth, a complaint relative to an overflowing cesspool was made to the State Inspector of Health who, after investigating, adjudged the conditions to be a nuisance and brought the matter to the attention of the local board of health. The nuisance was abated.

In East Bridgewater, near Center and Union streets, a considerable amount of surface water was held back in which refuse of various kinds found its way, constituting a nuisance. The matter was investigated by the State Inspector of Health and called to the attention of the local board of health, and the nuisance abated.

Factory Hygiene.

As a result of a recommendation of the State Inspector of Health, in one factory extensive changes were made, greatly improving the sanitation of the water-closets and the ventilation of the entire establishment.

In another establishment, as the result of a suggestion of the State Inspector of Health a blower system for the removal of dust in a room where bales of hemp are opened was installed.

Forty-eight inspections of factories were made and 9 conferences held with superintendents relative to sanitation. One of the conferences was in relation to the construction of a new building, and 2 were in regard to improved conditions of water-closets. Forty-four orders were issued, 43 of which were complied with. The order not complied with related to changes in a factory which later was destroyed by fire. In a shoe factory improved light was required in one department. In another establishment the ventilation was greatly improved in that part of the building which formerly was near the boiler room and exposed to coal gas and steam. In 10 factories the sanitation of water-closets was improved. In 6 shoe factories more efficient means were introduced for the removal of dust generated in the course of manufacturing processes. Outfits containing medical and surgical appliances were required in 5 establishments, and receptacles for expectoration in 14.

Health of Minors in Factories.

Total number of minors seen and questioned 581.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	9	35	70	63	58	57	38	330
Female,	16	25	49	49	48	34	30	251
Total,	25	60	119	112	106	91	68	581

No minors were found to be in ill health.

Health of Adults in Factories.

Two cases of tuberculosis in adults were brought to the attention of the local board of health and were properly cared for. One of the patients was found in the cutting room of a shoe factory. The man, thirty-five years old, had worked as a cutter in different factories for nearly fifteen years. The other patient, a man aged sixty years, was for many years a "bottom scourer" in a finishing room.

Schoolhouse Hygiene.

Fifteen schoolhouses were inspected, 2 of which were found to be unfit for use because of inadequate ventilation and improper light. Three other buildings needed improved ventilation.

The new high school building in Brockton has been completed, and the sanitary conditions therein are of a high order.

The new grammar school building in Kingston is completed and relieves the previously overcrowded condition of the high school building.

At the time of visit to the high school building in Whitman the ventilation of the rooms was distinctly bad, even with some of the windows open. No mechanical means were provided for the introduction of fresh or the removal of foul air. In the opinion of the State Inspector of Health the present building should be supplanted by a new one.

Slaughterhouse Inspection.

At the time this report was submitted there were 34 licensed slaughterhouses within the district. Only 3 of the slaughterhouses visited merited especial commendation so far as the sanitation of the building was concerned.

Water Supply and Sewerage.

The city of Brockton, as the result of the suggestion of the State Inspector of Health, extended the sewer to a point near the factory of W. W. Cross Inc., so that immediate connection was made with the factory, thereby discontinuing the pollution of Salisbury Brook from this source.

The sewer department of Brockton was urged by the State Inspector of Health to extend the sewer to the Brockton Hospital, and by so doing remove the offensive and unsightly filter beds at the hospital.

In Rockland, at the suggestion of the State Inspector of Health a polluted well was discontinued by the local board of health and town water was substituted.

Health District No. 4.

Elliott Washburn, M.D., *Taunton, State Inspector of Health.*

This district includes the cities of Quincy and Taunton, and the towns of Attleborough, Avon, Bellingham, Blackstone, Braintree, Canton, Dedham, Easton, Foxborough, Franklin, Holbrook, Hyde Park, Mansfield, Milton, Norfolk, Norton, North Attleborough, Norwood, Plainville, Randolph, Raynham, Sharon, Stoughton, Walpole, Westwood and Wrentham.

Diseases Dangerous to the Public Health.

Assistance was given to certain boards of health regarding the prevention of the spread of diseases dangerous to the public health as follows: board of health of Avon, as to whooping cough; of Hyde Park, as to tuberculosis and typhoid fever; of Easton, as to scarlet fever; of North Attleborough, as to tuberculosis; of Norwood, as to typhoid fever; of Taunton, as to typhoid fever; of Walpole, as to syphilis; and of Westwood, as to diphtheria.

The State Inspector of Health addressed audiences at Attleborough, Quincy and Taunton upon the "Nature and Prevention of Tuberculosis," in addition to discussing the best methods of preventing the spread of this disease with the local health authorities. A tuberculosis exhibit was held at Attleborough. Braintree completed shacks for the treatment of indigent persons afflicted with tuberculosis. For the purpose of studying methods of caring for persons ill with tuberculosis the State Inspector of Health visited the sanatorium at Sharon and the State school for crippled children at Canton. The State Inspector of Health found that physicians were becoming more reconciled to reporting cases of tuberculosis, and noted that employers and employees in many factories were interesting themselves in the question as to how they might best prevent the spread of this disease.

Conferences with Local Boards of Health.

Conferences were held with the boards of health of 18 cities and towns, and special data concerning the method employed by the local authorities in the prevention of the spread of tuberculosis obtained. It was the custom at the end of the conference to have an informal discussion on the different phases of public health work, and in this way considerable assistance was given to local authorities in carrying on their work. For the most part the conferences were at night. In several instances the local boards requested additional conferences. Aside from the conferences the State Inspector of Health made many visits to the offices of the local boards of health, and kept in constant communication with all the boards within his district either by letter or by telephone.

Local Nuisances.

The nuisances investigated included overflowing cesspools, offensive privies, unsanitary dwellings, offensive manure and land dressing, undrained land, dead horses, a brook contaminated with filth, and sewage. In each instance the attention of the local board of health was brought to the nuisance, and on several occasions the State Inspector of Health assisted said board in causing the abatement of a nuisance.

Factory and Workshop Hygiene.

The State Inspector of Health made 129 examinations of factories and workshops, of which 119 were thorough reinspections of establishments previously visited. As other duties prevented the inspector from making a complete study of all the factories within his district, those establishments in which minors were employed were selected. Additional visits were made for the purpose of studying some detail relative to the hygiene of the industry or to observe some special conditions. A marked improvement in general cleanliness was noted, and there appeared to be better co-operation on the part of both employers and employees in the matter of improved sanitation. Receptacles for expectoration were used in many establishments, and provided, but not used, in others. Some manufacturers appeared willing to take almost any means to prevent spitting, even to discharging any employee detected in the act, rather than have receptacles near machines or machinery. The State Inspector of Health observed the fact that tobacco has been used by the men to a much less extent because of the law requiring these receptacles, and attributed it, in part, to the requirement made by many employers that men using the receptacles must keep them clean.

Observations made on revisiting 119 factories and workshops showed that the following 30 faulty conditions had been remedied as the result of orders issued: receptacles for expectoration installed in 14 establishments; medical and surgical appliances in 8 establishments; improved cleanliness in 1; employees better protected against dust from emery wheels in 2; improved light in 1; improved ventilation in 2; improved water-closet and toilet facilities in 2. New orders were issued to the proprietors of 10 factories, as follows: in 1 instance for the protection of employees against acid fumes; in 4 instances for the protection of employees against dust from emery wheels; in 4 instances for the introduction of medical and surgical appliances; in 6 instances for the introduction of receptacles for expectoration; and in 6 instances for better water-closet facilities. In addition to the above written orders, requests were made orally to 24 employers to correct the following objectionable conditions: failure to protect adequately employees against acid fumes in 3 instances; lack of cleanliness in 4 instances; failure to regulate artificial moisture in 1 instance; failure to protect employees against dust from emery wheels in 1 instance; inadequate light in 2 instances; failure to protect employees against leather dust in 1 instance; inadequate ventila-

tion due to overheating and overcrowding in 6 instances; failure to provide receptacles for expectoration in 5 instances; failure to provide medical and surgical appliances in 4 instances; inadequate water-closet facilities in 10 instances.

In 87 factories visited no condition was noted sufficiently faulty to record.

In 2 cotton factories artificial light was supplied by kerosene lamps, which appeared to be inadequate in one weaving room. In the same room the humidity raised by artificial means was excessive at the time of inspection, but no order was issued since the employer was about to install a new humidifying system. In 4 jewelry establishments employees needed better protection from acid fumes. In 2 jewelry factories the ventilation was moderately bad because of overheated rooms, while in 4 factories a similar condition was caused by overcrowding. In 4 factories cleansing and whitening of the walls was recommended, to overcome the dirt and to improve the light.

Owing to the beneficial results of the work of the State Inspector of Health during the previous year a very much less number of objectionable conditions were found and a less number of orders issued to manufacturers. The sanitary conditions existing in factories within this district are markedly improved over the conditions in the same factories two years ago.

Court proceedings were instituted against the proprietor of a steel foundry for failure to provide properly for the protection of employees against dust arising from emery wheels. The case was continued for thirty days, during which time the defendant provided the required protective devices and was discharged by the court. Five large emery wheels used in the process of snagging steel castings were found by the State Inspector of Health to be unprovided with hoods and exhausts in accordance with sections 86 to 90, inclusive, of chapter 514 of the Acts of 1909.

Health of Minors in Factories.

During the year there were seen and questioned 2,277 minors, of whom 1,040 were males and 1,237 females. These minors were of the following ages: —

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	62	118	187	183	196	169	125	1,040
Female,	67	122	229	214	238	186	181	1,237
Total,	129	240	416	397	434	355	306	2,277

The following table shows the industries in which these minors were found and also the number of minors seen in such shops of every industry as were visited.

Nature of Industry.	Number visited.	Minors.		
		Males.	Females.	Total.
Bleaching and dyeing,	2	8	13	21
Celluloid combs,	1	-	2	2
Boxes, paper,	1	1	13	14
Chocolate and cocoa,	1	11	15	26
Foundries:—				
Copper,	1	6	2	8
Iron,	3	6	-	6
Gloves, kid,	1	1	10	11
Japanning leather,	1	22	-	22
Jewelry making,	52	305	573	878
Jewelry making and pearl working,	7	98	78	176
Jewelry making and electroplating,	2	3	2	5
Machine shops, all kinds,	14	151	12	163
Optical goods, cases only,	1	3	5	8
Pearl working. *See* Jewelry.				
Rivets and nails,	1	3	4	7
Rubber goods,	3	55	33	88
Shoes,	3	12	2	14
Shoe buttons, enameling,	1	1	-	1
Shoe laces and braids,	1	2	4	6
Shoe heels, wooden,	1	1	6	7
Shoe lasts, wooden,	1	8	-	8
Shovels and spades,	1	7	-	7
Silverware,	4	59	71	130
Stamping and plating,	1	1	-	1
Straw hats,	2	9	33	42
Textiles:—				
Cotton blankets,	1	9	19	28
Cotton cloth,	3	67	69	136
Cotton waste,	1	-	2	2
Cotton yarn,	7	165	205	370
Denims and tickings,	1	12	21	33
Gauzes,	1	12	11	23
Silk cloth,	1	1	10	11
Underwear, knitting,	1	1	20	21
Underwear, sewing,	1	-	2	2
Total,	123	1,040	1,237	2,277

No minors were found in a steel foundry, a brass foundry, a crucible works, a paper mill and a harness factory.

It was deemed advisable to make 186 physical examinations, for the following reasons:—

Tubercular family history,	58
Minor's previous history,	6
Minor's personal appearance (pale, thin, small, etc.),	95
Minors in special trades (pearl working),	27
Total,	186

Those examinations, which were made because of the personal appearance of the minors, were thought necessary because in 70 instances the minors were pale or thin, or both, while in 25 instances the minors were markedly undersized. The following conditions of ill health were disclosed by the examinations:—

	Cases.
Enlarged tonsils,	3
Epilepsy,	1
Cardiac disease,	1
Anemic condition worthy of note,	20
Total,	25

Letters calling attention to conditions of ill health were sent to the parents of 3 minors, the condition of ill health in every instance being enlarged tonsils. In 15 instances the State Inspector of Health believed the ill health was due, in part at all events, to the condition under which the minor worked, viz., to overheat and fumes from naphtha in 10 instances and to overheat in weaving rooms in 5 instances; to exposure to felt dust in 1 instance and to pearl dust in 3 instances.

The State Inspector of Health believed that he accomplished considerable good in correcting conditions of ill health of minors by conversing with the minors, pointing out to them explicitly just how they could improve their health.

Health of Minors in Factories in Relation to the Industry.

Information was obtained concerning the health of minors employed in the following industries. In all instances where avoidable unhygienic conditions were found the conditions were remedied in accordance with the statute requirements.

Chocolate and Cocoa. — Two boys, apparently well and healthy, were exposed to quantities of cocoa dust in the "cocoa room." In fact, they were covered with the dust from head to foot. The employer is intending to devise some plan by which the extent of exposure to this dust may be greatly diminished.

Japanning Leather. — Fifteen boys, mostly Italians, were constantly exposed to naphtha fumes to a greater or less extent. At times the fumes were very dense. The boys worked from 7 to 12 A.M. and from 1 to 4.30 P.M., and some of them ate their meals in the workrooms. None of the boys was found to be in ill health.

Jewelry. — In 1 factory in which the sanitary conditions were good 3 boys were noticeably pale but showed no other signs of ill health. In 1 factory 4 healthy boys were at work in a poorly ventilated room. In 1 factory several minors were exposed to acid fumes from a leaky shaft, although none appeared to be injuriously affected thereby. In another factory 6 boys were similarly exposed to acid fumes, but without apparent ill effect. In 1 factory where 9 boys and 5 girls were at work, and in another where 14 boys and 2 girls were employed, the ventilation was affected unfavorably by overheated and overcrowded conditions, and it was observed that several of the minors were pale. In 1 factory a girl was found who was pale and thin, and in another a girl who was pale, thin and undersized, although in neither case was any other sign or symptom of ill health discovered, and the sanitary conditions under which the girls worked were good. In 1 factory a girl with hypertrophied tonsils was found working under good sanitary conditions. In 1 factory a boy with marked pallor was found at work under good sanitary conditions. This boy it was discovered worked as usher in a theater every night in addition to his day's work. In 1 factory a boy with a considerable pallor was found exposed to lacquer fumes, while in another factory 3 healthy appearing girls were exposed to acid fumes. In different factories, all of which were maintained under reasonably good sanitary conditions, there were found 3 boys and 5 girls who showed considerable pallor, but in whom no disease could be detected on careful physical examination.

Machine Shops. — A boy, small and pale, who had adenoids and enlarged tonsils, was found working in a gauge factory under excellent sanitary conditions. A

small, narrow-chested boy with heart disease was found at work in an eyelet factory under good sanitary conditions.

Pearl Working. — A physical examination was made of 27 minors, 17 boys and 10 girls, who were exposed to pearl dust caused by the manufacture of pearl buttons, studs and ornaments. Seven of this number had been examined during the previous year. Of those previously examined and found to be in good health, 1, a boy, — whose length of time at work in this trade was one and one-half years, — was observed to have the marked pallor peculiar to such dusty trades. A girl who had worked at this trade continuously for one year and three months was pale and thin. On the other hand, 6 minors who showed no signs of ill health last year still appeared to be in good health. Five of the 25 minors examined were notably pale. A girl of sixteen years showed no sign of ill health after three days' employment in a factory where she was exposed to an excessive amount of dust and to inadequate ventilation, but when examined four months later was found to be suffering from constant dryness of the throat and dyspepsia symptoms, attributed to dust caused by the process of planing pearl shell, at which she had been employed during the winter. Acting upon the suggestion of the State Inspector of Health, 1 boy discontinued his work in the pearl grinding department and obtained employment in a machine shop under much better sanitary conditions.

Rubber Goods. — Two boys with marked pallor were found at work as spreader helpers in a rubber factory. In another factory 8 boys were markedly pale; here the sanitary conditions were distinctly bad, the department in which the boys worked being excessively hot, poorly ventilated and vitiated with naphtha fumes.

Silverware. — One boy who had worked in each of 3 silverware factories was observed to be pale. The sanitary conditions in each establishment were good.

Manufacture of Straw and Felt Hats. — Two healthy appearing boys were exposed constantly to much steam in a pressing room where steam was a necessary part of the process. In another factory a boy was found who showed considerable pallor but no evidence of disease. He was exposed to considerable quantities of felt dust in the manufacture of felt hats. The peculiar kind of work which he did was known as the process of matting, that is, shaping the felt into mats. Notwithstanding the fact that the machine was equipped with hoods designed to protect employees against the felt dust, a large amount of dust escaped from the front each time it was opened to remove the "mats." The boy worked with a partner, each alternating for an hour at both ends of the machine. Each of the employees wore large goggles to protect the eyes from dust.

Textiles. — In different mills of the cotton yarn industry 3 girls were pale, 1 thin and small and 8 were pale and thin, while in the same buildings 2 boys were markedly undersized, 2 were pale, 1 small and pale, and 3 were thin and pale. The conditions under which the young persons worked were good. In another cotton mill 8 of 20 minors found were so small as to cause comment. They were French Canadian by birth. Three were brothers in a family of 12 children. One girl, exceedingly small, was from a family of 9 children; another was from a family of 9 children; 1 from a family of 8 children; another, exceedingly small, was from a family of 13 children; and another, exceedingly small, was from a family of 8 children. The children were so small that notwithstanding the fact that the sanitary conditions under which they worked were very good, one might properly question whether they should be allowed to work in any mill. It was thought that overcrowding at home might in part account for their strikingly poor development.

In other cotton cloth factories there were seen 3 girls who were anemic who worked in a weaving room in which the standard of general cleanliness was poor, 2 boys thin and pale, and 2 girls, small and pale, in a weaving room in which the humidity and heat were excessive, and a girl with hypertrophied tonsils working under good sanitary conditions. Physical examinations showed no disease in any of these young persons.

In a mill where denims were manufactured and in a silk mill 1 boy and 2 girls appeared considerably pale although they were working under good sanitary conditions.

In a cotton-waste factory 2 girls, who from necessity stand at their work from 7 to 12 o'clock in the morning and from 12.30 to 5.30 in the afternoon, were exposed to the dangers arising from picking over by hand the cotton waste, much of which consisted of floor sweepings, which, without doubt, contained some dried sputum.

Efforts were made to follow up minors whose physical condition was below normal, but they were only partially successful, chiefly because of the amount of time which such work necessitated. In some instances the minors were removed by their parents from the establishments in which they were found and were in this way lost sight of.

The Hygiene of Occupation.

Jewelry Making and its Allied Industries, Electroplating and Enameling, Refining of Gold and Silver and Pearl Working. — A study was made of the hygienic conditions in the jewelry and allied industries in this district. One hundred and seventeen jewelry factories were visited in addition to 7 where pearl working and jewelry making were combined, 2 each where electroplating and enameling jewelry was done, and 3 where the refining of precious metals was carried on. During a period of industrial depression, when these factories were visited, there were found employed 5,753 persons, of whom 3,534 were males and 2,219 females. Of these employees, 702 were less than twenty-one years of age, 260 of whom were boys and 442 girls. Later, when industrial conditions were improving, 69 of the factories mentioned were examined, and 1,059 minors found, of whom 406 were boys and 653 girls. The materials used in the so-called allied trades are gold, silver, aluminum, brass, various solders and enamels, lacquers of varying composition, celluloid, glass, pearl shells, jewels and precious stones and imitations assembled, including nitric, sulphuric, hydrochloric and glacial acetic, cyanide of potash, ammonia, soda and "kali" solutions, crocus, borax, solutions of bran and shorts and of soap tree bark, sour beer, ashes in rubbing celluloid and in the refining of gold and silver, floor sweepings and liquids containing dust from polishing wheels. The machinery used in the industries mentioned includes presses and stamps of both foot and hand power, lathes of different sizes, machinery for ruling and drawing, drilling machines, milling, grinding and planing machinery, emery wheels and polishing wheels of other kinds, — the most common of which is the "rag" wheel, — grindstones, small sand blasts, pan grinders for grinding ashes, forges for metal melting and mixing; while in the pearl working indus-

try machines were found for sawing, cutting, doming, planing, carving, drilling or otherwise working pearl shell.

The factory buildings are constructed for the most part of wood, some of brick, while one is of concrete. A factory which is ideal from a sanitary point of view was found in a one-storied building. It was exceptionally well lighted and ventilated. Generally the buildings have two, three, four or five stories, and contain from two to eight different companies. The buildings vary greatly in age and structure. Among the older ones were found the faults common to such buildings, viz., insufficient height between floors, inadequate ventilating provisions and much poorer light than is found in the modern buildings. In the ideal modern factory the coloring department is separated from the main room. The best jewelry factories in which pearl working is done separate the pearl working rooms from the jewelry making rooms, — in other words, the very dusty processes from the less dusty ones. Following is an account of the possible unhygienic conditions to which employees in the jewelry industry are exposed. It is not always some one condition which may be injurious to health but often a combination of unhygienic influences.

In 15 jewelry factories the sanitary conditions were found to be above criticism, while in 80 such factories, 2 electroplating shops, 2 enameling rooms, 3 refining establishments and 6 factories where pearl studs or ornaments were manufactured, one or more conditions were noted as being possibly injurious to the health of the employees. In 4 factories the light was moderately bad; in 4 the ventilation was inadequate; in 6 the general cleanliness was below the standard set by the best manufacturers; and in 9 employees were found to be improperly protected against fumes and vapors in rooms which were overheated, in addition to being exposed to poor light, inadequate ventilation and considerable dust.

Extremes of Heat.

An unhygienic factor commonly found in jewelry and electroplating factories was excessive heat. This is especially noticeable in old and low buildings, and is due to the following conditions, which were naturally more exaggerated in small, old and low-studded buildings: —

(1) The use of steaming hot solutions in open crocks in open sinks, commonly located in the center of the room.

(2) The heat from small or large forges used in melting metal.

(3) The use of gas jets of the Bunsen burner type in soldering.

(4) The refusal or neglect of employees to use the means of ventilation provided.

(5) Overcrowding.

In those factories wherein the processes of blowing or pressing glass were conducted the heat was distinctly oppressive. The employees who attended the gas furnaces were also exposed to a high degree of heat, although they were in a measure protected by blasts of cold air forced through rubber tubes, each workman being supplied with a tube. It was noted that the blast of cold air struck the worker at about the middle portion of his chest.

In the jewelry factories it was noted that the heat from the open sinks was practically steam so that to the unhygienic factors above mentioned should be added that of dampness.

Overcrowding.

During the growth of the jewelry business more persons have been employed than it was intended to employ when the factories were constructed. Consequently, employees and machinery have been added until the whole space has become overcrowded, and the cubic air space per capita much below the standard which should be required in a new building. Such a condition obviously is difficult, and indeed in many cases impossible to remedy satisfactorily.

Fumes, Gases, Odors and Smoke.

In the most modern factories fumes and odors caused by various processes in the manufacture of jewelry were barely perceptible, but in the older buildings, particularly those which are small, low studded and very inadequately ventilated, such fumes and gases must have some slight injurious effect upon health. Ammonia fumes were perhaps most constantly present, ammonia being used in the "washing-off" process commonly conducted in open sinks in the center of the workroom. At times the fumes were noticeable to an extent that they were distinctly objectionable.

Weak solutions of cyanide of potash are generally kept in open crocks in the open sinks in the main workroom. The only practicable question as to the harmfulness of such solutions is in connection with other slight or marked unhygienic influences, each depending mainly upon the age and construction of the building. Lacquers are said to contain gun cotton, ether, amyl alcohol and other substances, and are very inflammable. The fumes are disagreeable, and as the work requires heat up to about 100° F. it is not inviting. In those establishments where the process was carried on in a special room where no one was employed long at a time, and in those establishments which carried on the work under hoods equipped with adequate exhausts, the odors and fumes did not escape into the main workroom to any objectionable extent. On the other hand, lacquers were often used at the benches in the main room, and in such cases were distinctly objectionable. In 2 instances it was found that girls gave up their work because of the disagreeable odors and irritating fumes, which not infrequently among beginners give rise to headache, nausea and irritating cough. No permanent ill effects have been recognized although it was noted that when workers had remained at home for a week or more upon returning to work they were again affected by one or more of the symptoms mentioned. Consequently, it would appear that the odors and fumes caused by the process of lacquering have an unfavorable effect upon those who are constantly exposed to them.

A not inconsiderable part of jewelry making consists of soldering together the small parts. The necessary heat is generated by Bunsen burners, the gas for which is brought through rubber tubes to the workers at the benches at which the process is carried on. The amount of escaping gas was at times

distinctly noticeable, and aside from the amount which escaped as the result of imperfect combustion a certain amount escaped from rubber tubes which became more or less porous after a long period of time and permitted the gas to escape. It appeared to the State Inspector of Health that the rubber tubes should be renewed more frequently than was the custom. As the Bunsen burner was used at a distance of about 16 inches from the face many of the bench workers must breathe air, itself overheated, vitiated by gas. Of the bench workers about two-thirds were women and girls.

The danger from nitric, hydrochloric and sulphuric acid fumes was found to be reduced to a minimum by means of hoods with exhaust ventilation. In many of the larger factories the fumes were drawn into so-called acid stacks, which, in order to prevent spontaneous combustion, due to the action of the acids on the stacks, were lined with asbestos or glass. In a few of the smaller factories these acids were used in crocks on benches near windows, wooden covers without exhaust draft being provided to protect the workmen against fumes which should pass through the open windows. In such factories at times the irritating acid fumes were not only recognized near the benches but penetrated for a considerable distance into the workrooms. Moreover, it should be said that even in the factories which were equipped with the best hoods and exhausts designed to protect the workmen against fumes, there were certain conditions of the wind and atmosphere which at times caused back drafts, thus carrying the acid fumes back into the workroom.

Other more or less objectionable offensive odors resulted from the use of glacial acetic acid in the jewelry branch of the industry, of sour beer, solutions of soda or bran and shorts and soap tree bark in the so-called "scratch-brushing" process, and other solutions the composition of which was not learned.

In the majority of the jewelry factories the processes of coloring and acid dipping were conducted in the main room of the factory, while in the most modern establishments these processes were conducted in rooms which were entirely separate from the main workroom. Moreover, the separate rooms constructed for the purpose were equipped with adequate hoods and fans for the removal of the fumes, thus protecting not only better the employees in charge of the process but preventing escape of any of the fumes into the main workroom, where employees in other branches of the industry were at work.

In the metal rolling and drawing departments and in the refineries more or less smoke escaped from the furnaces into the workrooms.

Dust.

The principal sources of dust in this industry were found to be (1) from polishing metal and cotton cloth wheels at the polishing benches, (2) from the process of grinding ashes in the work of refining gold and silver or sweep smelting, (3) in the manufacture of pearl goods, and (4) from the small sand blasts. The amount of dust which escaped into the rooms from the use of the sand blast was exceedingly small since each blast was found to be covered with

glass, and the men worked through hand holes, protecting their fingers from the sand by finger cots.

Because of the nature of the metal and its commercial value, every factory was found to be provided with efficient hoods and exhausts in connection with the process of rubbing or polishing. The dust was collected in barrels or tanks of water, from which the metal was renewed by refinement.

The different processes in the manufacture of pearl shell goods, with the attending varying amounts of pearl shell dust, have been described in a previous report under pearl working. Notwithstanding the best protective devices found in the way of hoods and exhausts, there was some escape of dust, as was evidenced by the fact that the fine white pearl dust covered the belts, machines, walls, ceilings, clothing and often the faces of the workers in those establishments which provided the most improved methods of protection. In 1 jewelry establishment in the pearl working department 6 girls were found exposed to an excessive amount of pearl dust.

In the work incident to the refining of gold and silver one process was that of grinding ashes to a powder. When this is done in iron barrels which are tight, in which are small iron balls, the dust does not escape, but when it is done by means of the "pan grinders," or large heavy stone wheels revolving in metallic pans, a great amount of dust is created. This latter process was usually found to be conducted in a small room, in which, however, no one was constantly employed. While the nature of the process prevented efficient removal of the dust in 1 factory the machinery was connected with a large dome-shaped hood and a blower which removed most of the dust.

Light.

The majority of the persons employed in the jewelry industry are known as "bench hands." Their work is to solder and assemble the small parts, or to attend to such processes as enameling. The employees sit at benches which run along the walls of the room, usually facing the windows, the lower sashes of which are on a level with the benches, and use their eyes constantly on near work throughout the day. In 1 factory the lower sashes of the windows were at a considerable distance from the top of the benches, making a dark space between the lower sash and the bench. The employees complained of poor light. Some of the benches were placed at right angles to the walls and extended into the rooms, while others were placed parallel to the walls, and were located in the center of the rooms. With benches improperly placed with reference to light, for example, when employees constantly face too strong light, with inadequate artificial light in the late winter afternoons and on dark days, one might expect eye fatigue or eye strain or headaches dependent upon eye strain to follow. Many of the employees were found to wear eye shades, while about one-half wore glasses. In some of the workrooms where the smaller presses and the large stamping machines were located the light was greatly interfered with, owing to the fact that much of the machinery extended from floor to ceiling, and not infrequently occupied the greater part of the room.

Ventilation.

The problem of adequately ventilating old, low-studded, overcrowded workrooms is one which must be considered to a considerable extent in the jewelry industry. Moreover, the conditions are made worse by extremes of heat, fumes and odors which were commonly noted in such buildings.

In most of the factories the ventilation would be greatly improved if the employees would make use of the means of ventilation provided, but, owing largely to fear of drafts, the windows and transoms were generally kept closed. In several factories window ventilators were found, while in others large fans were kept in constant operation, and in 2 factories a special ventilating system was introduced.

Seats for Employees.

On account of the nature of the work more than half the employees in the jewelry industry sit while at their work throughout the day. For seats chairs with the ordinary wood bottom and curved back are used. The chairs with few exceptions are of uniform height and are not adjustable. Consequently, some of the employees are compelled to assume unhygienic postures. It was evident to the State Inspector of Health that in many instances the chairs were uncomfortable for the employees, that they did not properly support their backs, and that the distance between the top of the bench and the seat was inconsistent with a correct posture and with the requirements of normal vision. Backaches and fatigue were common complaints. In many instances employees were observed using flat boards, cigar boxes or other means of support to their backs. It was roughly estimated that under normal business conditions there were at least 5,000 persons in the factories sitting at their work practically throughout the day.

Following is an example of a jewelry factory of recent construction, except for the provision for seats, with satisfactory conditions. The rooms are high studded. The light in every part is admirable. Adequate ventilation is provided for by windows, transoms, fans and ventilating shafts through the roof. Extremes of heat are avoided. Buffing wheels have efficient hoods and exhausts. The coloring and dipping processes are conducted in separate rooms, from which no objectionable fumes escape into the main room. Lacquering is done in a small isolated building where no person is constantly employed. Pearl working, likewise, is done in a separate building, 50 by 30 feet, under very good conditions, considering its intrinsic dangers. Proper water-closet facilities are provided.

Hygiene of Public Buildings and Schoolhouses.

Complaints were received relative to the ventilation of certain schoolhouses in Braintree, Randolph, Sharon and Taunton. These schoolhouses were investigated and reports of existing conditions were filed with the State Board of Health. The attention of the authorities of Braintree, Randolph and

Taunton was called to the inadequate ventilation of the schoolhouses and improvements were made in every instance. The conditions found in the schoolhouse in Sharon were beyond the scope of the authority of the State Inspector of Health.

During the year 16 other schoolhouses were thoroughly examined as to their ventilation and provision with proper and sufficient water-closets, earth-closets or privies.

The schoolhouses examined were taken as was convenient, and were not selected. Some of the buildings were more than fifty years old, others were new. It was noted that in some of the older buildings the ventilation was even better than in some of the newer buildings. Following is a summary of the conditions observed as to ventilation, light, general cleanliness and toilet facilities: —

In 6 of the buildings ventilation was adequate in all the class rooms. In 6 other buildings ventilation was good in some of the class rooms and moderately bad in others. In 2 instances the ventilation of some of the class rooms was distinctly bad. In 2 other instances ventilation was moderately bad in all the class rooms.

The light was found good in 10 schoolhouses throughout. In the other 6 schoolhouses the light was good in some of the class rooms and moderately bad in the others.

In 6 of the schoolhouses there were a sufficient number of proper water-closets or privies; in 6 there were poor systems of closets, with infrequent flush and offensive urinals; in 2 the privies were offensive; in 1 the number of closets for the girls was insufficient, and in 1 instance the privies were too far from the school building.

The general cleanliness of all the schoolhouses was found to be good.

In June, 1908, the State Inspector of Health called to the attention of the mayor and the city council of Taunton the fact that the central police station in Court Street was inadequately ventilated and not provided with a sufficient number of proper water-closets; that in each respect section 54 of chapter 106 of the Revised Laws was violated, and that said section must be complied with. In 1909 the city council appropriated the sum of $30,000 for the erection of a new police station, which at the time of writing was in process of construction.

Tenement Hygiene.

Seven licenses were granted for sewing on wearing apparel in tenements.

Slaughterhouse Inspection.

An examination was made of the sanitary conditions existing in those places where animals were slaughtered for food purposes, and it was found that there were 48 slaughterhouses or places where slaughtering was done. One proprietor only was found to have premises worthy of special commendation from the point of view of sanitation. In 26 instances conditions were found to be reasonably satisfactory, in 13 moderately bad, and in 8 distinctly bad.

The objectionable conditions consisted of general lack of cleanliness of walls and floors, lack of proper methods of disposal of offal, lack of facilities for cleaning slaughtering rooms or washing slaughtered products, filthy cellars under slaughter barns, dirty refrigerator rooms or cooler, dirty tubs, knives and utensils, and collections of stinking bones and offal in rooms where slaughtering was done. In 1 instance meat was allowed to cool over night in a room a part of which occupied for a hog pen was particularly filthy and objectionable. As a result of repeated visits to the slaughterhouses the State Inspector of Health found that the persons who did the slaughtering lacked, for the most part, a general knowledge of the laws of the Commonwealth relating to slaughtering and meat inspection, and that in numerous instances, especially in the towns, the legal provisions were ignored. In 6 instances it was found that the proprietors had no license to slaughter, although in 2 of these instances proper applications had been made to the board of selectmen. In 1 instance the board told the applicant that no license was necessary. In the other, failure to grant the license was due solely to neglect. In 4 cases no application for a license was made.

As the result of the investigation of the State Inspector of Health, and the general agitation on the subject, there was noted on reinspecting the establishments a great improvement in cleanliness. Six unlicensed proprietors had procured licenses. One town had appointed an inspector; another had allowed an inspector who was unable to attend to his duties to resign and obtained an active inspector. One city, Taunton, was refusing to renew licenses until the premises met with the approval of the board of health, and the board refused to renew two licenses on the ground that the premises were unfit for slaughtering. The State Inspector of Health found that two licensees in different towns built new slaughtering barns, and noted a more strict observance of the slaughtering laws generally. The State Inspector of Health in the course of his investigation found it necessary to conduct a prosecution against one proprietor on two counts (1) for slaughtering without a license and (2) for having in his possession with intent to sell unstamped meat. The defendant was found guilty, and upon agreeing to discontinue illegal work was discharged upon payment of costs. He subsequently secured the required license.

Matters relating to Water Supply and Sewerage.

The State Inspector of Health investigated and reported upon conditions which tended to pollute the waters of Lake Pearl in the town of Wrentham, used for drinking and other purposes by the occupants of about fifty cottages and by the frequenters of a large summer park upon its borders. Although not a public water supply the water was used by many people during the course of each year. It appeared that the water was polluted as the result of bathing, fishing and skating, and through soakage from privies to the banks of the lake. At the time of the investigation 15 persons were bathing within fifty feet of the end of the pipe through which was taken all of the water that was used at the park.

Health District No. 5.

Harry Linenthal, M.D., *Boston, State Inspector of Health.*

This district includes Suffolk County.

I. Hygiene of Tenement Workrooms.

The need of frequent inspection of tenement workrooms in the congested district was apparent on finding conditions of uncleanliness and overcrowding which did not exist at the time the license was issued. Frequent unexpected visits to some of the worst places, and the revoking of a license here and there on account of uncleanliness, had a good effect, and served as a powerful motive to maintain fair sanitary conditions on the premises where work on clothing was done.

Because of difficulty in tracing the workers, who moved about frequently without giving notice, an effort was made to get the employers to submit each month a list of all their tenement workers. Such lists are now submitted with far greater regularity, consequently rendering the supervision and tracing of the workers easier.

In several instances it was learned that tenement workers transferred their licenses to others, who presented them at workshops and obtained work, the employer not knowing that the one who presented the license was not the person to whom it was issued, and that the work was taken to premises other than those designated on the license. In every instance where this act was discovered the license was revoked, so that others might be prevented from illegally transferring their licenses at the risk of losing the right to carry on the work. At the present time it is believed that there is very little, if any, work carried on in unlicensed places. Prompt attention to applications for licenses and the issuing of licenses where the sanitary conditions warrant it, removes the temptation from the employer to give work to

unlicensed persons, since he can find a sufficient number of licensed workers, and thus not run the risk of legal prosecution. That it is difficult to obtain work without a license is demonstrated by the fact that in some instances, where licenses were refused on account of unsanitary conditions, the applicants made frequent requests for the license without which they could not obtain work.

In a previous report it was pointed out that many of the women worked excessively long hours, and that they were particularly overworked in the busy season, when the employer was rushing the work. Not only do the workers, who do all their work at home, work long hours, but occasionally women who work in the shops apply for a license, and, if the license is granted, take work home with them at night. The legal restriction of hours of work for women is thus removed in many instances.

During the year 136 licenses were refused and 137 revoked. The objectionable conditions most frequently found necessitating the refusal or the revoking of licenses were uncleanliness or overcrowding of the premises. Subletting of rooms to lodgers or providing quarters for new arrivals frequently overcrowd a flat in a tenement which was previously taxed to its full capacity by the members of the family. Bedrooms were found which were occupied all of the twenty-four hours by day and night shifts.

One of the most revolting conditions was observed in a small flat in a narrow street in the North End of Boston. A two-room flat was occupied by a family of seven, the parents and five children. A toilet room leading off the kitchen, which was a little larger than the ordinary toilet usually found in tenement houses, had a bed in it where three of the children slept. The toilet was dirty and the odors in the room were offensive.

1. Ventilation of Tenements. — The condition of the air in the tenements, particularly during the cold weather, was found to be distinctly bad. The windows as a rule were tightly closed all through the winter. In many instances rags and papers were used to close all the crevices between the window sashes. As a result of this, together with the odors from cooking, etc., the air in the rooms was foul. In several instances dizziness and headache were caused by remaining in the room for five or ten minutes. The air in the bedrooms was found still worse than in the kitchens. A series of tests were made to estimate the quantity of carbonic acid gas in the air of these rooms. The average of 25 tests showed 21.6 parts of the gas to 10,000 parts of air in the bedrooms and 20 parts of the gas to 10,000 parts of air in the kitchens. If one bears in mind that the best authorities regard a total of 6 or 7 parts of carbon dioxide to 10,000 parts of air as the permissible limit, and 10 in 10,000 as distinctly harmful, one can form an idea as to how bad the air is in these rooms and what must be the result of its continued effect upon health. Moreover, the staleness and foul odors of the air cannot be submitted to tests.

Nothing but educational work among the people to teach them that an open window is not a menace to health will improve such conditions. The following regulations for tenement workers, now being translated in Italian,

will, it is hoped, tend to improve the sanitary conditions in the tenement workrooms: —

1. The apartments, stairs and hallways must be kept in a cleanly condition at all times.

2. The rooms must be well aired. The windows of the living rooms as well as of the sleeping rooms should be partly open at all times.

3. The sewing should be done in the room designated by the State Inspector of Health and in no other room.

4. During the process of finishing, the garments should not be placed in any room that is used as a sleeping apartment.

5. Immediate notice should be sent to the State Inspector of Health in case of occurrence of a communicable disease in the family of the person holding the license, or in any family in the same building. Any case of skin disease in the family of the person holding the license should also be reported to the State Inspector of Health.

6. In case of removal immediate notice must be sent to the State Inspector of Health.

7. The work on wearing apparel must be done on the premises designated on the license and only by the members of the family of the person holding such license.

8. The number of occupants of the apartment should not exceed the number specified to the State Inspector of Health.

9. The license may be revoked on violation of any of the above regulations.

2. Tuberculosis in Tenement Workrooms. — Six persons reported ill with tuberculosis in tenement workrooms were visited, and licenses were revoked in five instances on account of the active stage of the disease. In one instance the member of the family suffering with the disease went to Rutland State Sanatorium and the license was reissued.

The following case is cited to illustrate our present inadequate methods in not providing for the after care of persons discharged from the State Sanatorium as cured or with the disease arrested. In September, 1907, a two-room flat in a narrow, dirty street in the North End was visited. In the two rooms there lived a young man of twenty-five with his mother and grandmother. The two women finished trousers at home, — their only means of subsistence. The young man was so ill with tuberculosis that he was unable to work. A small, low-studded room used as a kitchen and workroom served at night as a bedroom for him. When the house was visited a small kerosene stove was burning and the family dinner cooking. The windows were tightly closed and the air in the room was suffocating. The young consumptive stayed at home as he was "indisposed" to go out. He was subsequently admitted to Rutland, where he stayed for several months and from where he returned, with the disease apparently arrested, to live in the same two-room flat under the same unsanitary conditions. He got along fairly well for a time, but in the spring of the current year the tubercular process became very active, ending in his death in August.

3. Prosecution. — Court proceedings were instituted against Smith &

Cohen, 9 Friend Street, Boston, on two counts. (1) For giving out work to a woman who had no license and (2) for not keeping a register of the tenement-house workers. The case came before Judge Wentworth on March 30, 1909. The firm was found guilty and a fine of $200 was imposed. On appeal, the district attorney, after consultation with the State Inspector of Health, reduced the fine to $100, which was paid.

4. *Numerical Data.*

Total number of visits to tenement workrooms,	1,638
Number of licenses granted,	613
Number of licenses refused,	136
Number of licenses revoked,	137
Not found and not in,	169
Reinspected,	720

Of the licenses revoked, 37 were revoked on account of communicable diseases, as follows: —

Diphtheria,	16
Scarlet fever,	5
Measles,	10
Chicken pox,	1
Tuberculosis,	5
Total,	37

Nine cases of impetigo contagiosa were also discovered in tenement workrooms. In 4 cases licenses were refused because one or more of the children in the family were suffering from the disease. In 5 the licenses were revoked, the children were placed under treatment and when the disease cleared up the licenses were reissued.

II. *Hygiene of Clothing Factories.*

Eighty-two visits were made to clothing factories. With the exception of two new establishments all were visited during the previous year. The standard of cleanliness was, on the whole, better than previously found. In many establishments the sputum receptacles were found in good condition and less spitting on the floors was noticed; also, anti-spitting notices were posted in conspicuous places. In other factories, however, the sputum receptacles were dirty, or were stuffed with rags and placed under benches and tables where they could not be used.

III. *Hygiene of Candy and Chocolate Factories.*

During the year 50 visits were made to 27 candy factories. These included large factories employing 800 or 900 workers, as well as small shops where only 3 or 4 persons were at work. The large factories were all located in

modern buildings and the workrooms were large, airy and as a rule well lighted. In several establishments the conditions were highly commendable; they were clean, the ceilings and walls were white, the rooms high studded, light and airy, and sputum receptacles were provided where needed. In several factories dining rooms were provided for the employees. In one establishment notices were posted in every room, both in English and Italian, quoting the anti-spitting laws and ending as follows:

> Any one in our employ spitting on the floor in violation of the above laws will be immediately discharged. Your attention is called to the receptacles for that purpose in your room.

In some of the smaller factories the sanitary conditions were fairly satisfactory. Among some of the objectionable conditions observed in these establishments were several overcrowded rooms, particularly the dipping rooms; dirty floors with sugar crusts on them, in places several inches thick; dirty, sugar-covered walls; uncleanly receptacles for the chocolate, and evidence of expectoration on the floors where men worked. Eleven written orders were issued for proper sputum receptacles, 10 of which were complied with. One firm went out of business.

Orders to install first-aid outfits were issued and complied with in 2 establishments.

In seven establishments orders were issued for greater cleanliness. In 2 buildings the conditions were very bad; the floors were covered with thick crusts, the walls were dirty, and the rooms looked dark and dismal. In both these places the floors were thoroughly cleaned and the walls and ceilings were whitened, thereby greatly improving the light in the rooms. In 4 other factories a higher standard of cleanliness was maintained. One firm moved. Improved conditions in the water-closets were ordered in 2 establishments and the orders were complied with. In 1 factory it was suggested that the water-closets which ventilated into the factory be so changed as to ventilate outside. This factory has not yet been reinspected.

Men, women and girls are engaged in the candy industry. The boiling of the sugar, the making of hard candy and the making of the cream is done entirely by men, while the dipping of the chocolates, either by hand or by machines, and the wrapping and packing are done by women and girls. The higher grade of chocolates is dipped by hand. The chocolate, after it is boiled in large vats and converted into a thick liquid, is brought into the dipping rooms and poured on metal trays near which the girls are seated. The moulded creams, the fillings for the candy, are then immersed by the dippers into the liquid chocolate and by a few deft movements completely coated. In this process the entire hand of the dipper is immersed into the chocolate. In several establishments great care is taken as to the hands of the operatives; ample washing facilities are provided and the management insists on frequent washing of hands. In others frequent routine inspection of the hands is made. In one establishment a trained nurse visits the place periodically to inspect the hands of the dippers.

The dipping rooms are artificially cooled by circulation of iced brine through pipes. In the hot summer weather these rooms are very comfortable, a uniform temperature of about 68° being maintained.

Candy workers are frequently subject to caries of the teeth, due to the eating of candy and lack of cleansing the teeth and gums. Of 80 minors examined in several candy factories 50 per cent had decayed teeth, — the teeth most frequently decayed were the molars. The excessive eating of candy occurs only among beginners.

The decay and loss of the teeth was most striking among the hard candy makers, all of whom were men. Of 20 examined, engaged in this work, 12 had false teeth, both upper and lower; 3 had badly decayed teeth, while but five had teeth in fair condition. Two men ascribed the loss of their teeth to the great quantities of candy they have had to eat in tasting the mixtures. Such a practice, however, is not general. In most places the ingredients, sugar and flavoring extracts, are determined exactly by weight and the men eat very little candy. Some of the men ascribed the diseased condition of the teeth to the fumes which arise from boiling sugar, although the true explanation is probably the handling of large quantities of sugar in a pulverized condition, which gives rise to considerable sugar dust. This dust settling on the teeth, which are not cleaned, ferments and causes them to decay.

IV. Hygiene of Cigar Factories.

In the last report upon the hygienic conditions in cigar factories especial attention was called to the inadequate ventilation of the factories and to the objectionable practice of finishing cigars by the aid of saliva. These matters were taken up with the employers and with the Cigar Makers' Union, and certain general recommendations were made. Subsequent visits to the cigar factories showed that while the habit of biting the ends of fillers and the custom of using saliva in finishing cigars were observed in a few places, they were not so prevalent as on first inspection. Several firms posted notices in their factories strictly prohibiting these practices.

The problem of properly ventilating the factories was a more difficult one. Many of the firms to whom letters were sent last year have been carrying out the suggestion of opening the windows before work began in the morning and during the noon hour, but the change of air thus brought about was not sufficient. Examinations made during the cold weather showed the ventilation of the factories to be very bad. All the windows were found tightly closed and in many instances burlap and paper stuck into all the crevices. The air of the workrooms, heavily charged with the strong, pungent odor of tobacco leaves was foul. The rooms were hot and stuffy. In one small factory there were about 50 people working in a very large room. The ceiling was low, all the windows were closed, and burlap was stuck between the sashes. The air was distinctly bad. The room was heated by two large coal stoves.

A series of 25 tests in 13 cigar factories was made to determine the amount of carbon dioxide in the air. The average test showed 22 parts of

carbon dioxide to 10,000 parts of air. In the factory above referred to there were 28 parts to 10,000. In the stripping room, where girls were employed, the conditions were a little better, as the windows were opened occasionally.

As a result of issuing orders to provide better ventilation, conditions in several factories were considerably improved. In 2 establishments window ventilators, which deflect the current of air from the open window, thus minimizing the exposure of the employees to drafts, were installed. In 1 factory a trap door was opened in the ceiling into a loft above, where the windows are open all the time. In the factory described above, where the conditions were so bad, an electric exhaust fan was put into one of the windows. This fan is operated several hours each day. Several window ventilators were also provided. In one large factory an open pipe one foot in diameter was carried from each workroom to the roof. This improved conditions somewhat, but some artificial means, such as electric fans or heating coils, will have to be used to increase the suction in these pipes. In another large factory ventilating flues were constructed with two grated openings near the ceiling and floor of each workroom. These flues are carried to the roof and are tapped by revolving cones, which, when the wind is blowing, create a vacuum in the flues, thus causing suction. This system is dependent to a large extent on the condition of the weather. Later in the winter exact tests are to be made as to the efficiency of this system.

The best results thus far obtained as to ventilating provisions are in a five-story building wherein 600 to 700 workers are employed. The floors where the cigars are made are large, square rooms in each of which 180 to 200 cigar makers are at work. There are windows on two sides of these rooms. The light in the center of the room is not good and gaslights have to be used during the day. This constant burning of about 20 gas jets helped to make the air in the rooms, already poorly ventilated, considerably worse.

In spite of all efforts, the management did not succeed in ventilating the rooms by means of the windows. Even if a window were partly opened occasionally it was found that the change of air thus caused was not sufficient to purify the air in such large rooms. It was therefore suggested to the owners, who were anxious to improve conditions, that an artificial ventilating system would be necessary to obtain adequate ventilation in these workrooms. Such a system has now been installed and has been in operation for about six months. It consists of ventilating flues on each floor, so arranged that the air can be taken from the top or the bottom of the room. These flues are connected with a large exhaust fan revolved by an electric motor. Tests made with the anemometer showed that when the fan was in operation 10,000 to 12,000 cubic feet of air per minute were taken from the building; the air of the workrooms would thus be changed three times an hour. To further test the efficiency of this system the superintendent of the factory was instructed that on a given day he was not to put

the fan in operation, but to keep the workrooms as they were formerly. On visiting the workrooms in the morning, they were found hot and stuffy. Tests for the determination of carbon dioxide on three floors gave the following results: —

Third floor. — Carbon dioxide 26 parts to 10,000 parts of air.
Fourth floor. — Carbon dioxide 28 parts to 10,000 parts of air.
Fifth floor. — Carbon dioxide 28 parts to 10,000 parts of air.

The fan was then set in operation and the windows were opened a little at the top. Forty-five minutes later another visit was made to the factory. The air seemed a good deal better and the odor of tobacco was not so strong. Tests were made, with the following results: —

Third floor. — Carbon dioxide 10 parts to 10,000 parts of air.
Fourth floor. — Carbon dioxide 9 parts to 10,000 parts of air.
Fifth floor. — Carbon dioxide 9 parts to 10,000 parts of air.

The following letter was written at the request of the owners, to help them obtain the co-operation of their employees in the proper ventilation of their factory: —

I visited your factory a few days ago and made some tests of the new ventilating system recently installed. When in operation the foul air can be taken from the building at the rate of 10,000 to 12,000 cubic feet per minute. This will allow a complete change of the air of the workrooms about three times every hour. Tests made of the air of the workrooms when the fan was not in operation showed 28 parts of carbon dioxide to 10,000 parts of air, which indicated that the air was foul. After opening the windows a little and starting the fan the carbon dioxide in the air was reduced to 9 parts to 10,000 within one half hour, and the air of the rooms felt fresh and conditions were very satisfactory.

To get the fullest benefit of this ventilating system the intelligent co-operation on the part of your employees is necessary. They should be given to understand that if 10,000 cubic feet of air is taken from the building every minute, means must be provided whereby fresh air can come in to replace the foul air removed. If the windows are kept open a little at the top a sufficient inlet of fresh air will thus be provided.

The cigar makers must be made to realize that adequate ventilation of the workrooms is a matter of vital importance to them. Figures of the United States government census show that, next to stone cutters, cigar makers head the list in the rate of those who die of consumption. The stuffy, poorly ventilated workrooms are undoubtedly in a large measure responsible for this high death-rate from tuberculosis.

A thorough realization on the part of your employees of the need of fresh air in the workrooms, and an intelligent co-operation on their part, are necessary to get the fullest efficiency of the ventilating system which you installed.

Since the letter was sent the factory has been visited several times and a number of the employees have been spoken to both inside the factory and

outside. They all agreed that the change in the conditions was quite striking. Several stated that they were able to do more work afternoons, as they felt more active. Formerly it was necessary to close the factory on very hot summer days, but this season the employees worked through the hottest weather without undue discomfort.

V. Processes of Metal Polishing and Buffing.

Metal polishing and buffing are processes carried on in a variety of industries under varying conditions. The establishments visited included the occupations of metal plating, brass manufacturing, manufacturing of plumbers' supplies, of gas fixtures, of stoves and of various sorts of machinery.

Metal polishers are exposed to iron, steel, brass and copper dust, according to the nature of the work, and to the emery and cotton dust from the polishing and buffing wheels. The rough, unfinished castings from the foundry are ground on emery wheels to the desired size and shape. They may then be burnished on "buffing wheels," which are made up of circular pieces of cotton cloth firmly clamped or sewed together in the form of a wheel. While some employees admit the effects of dust irritation of the nose and throat, others, including employers, speak of the work as "healthful," especially the process of polishing iron, which, they assert, "is strengthening, as it enriches the blood." In one establishment a man about fifty years of age, at work without protective devices for more than fifteen years on brass, nickel and steel polishing, was found by a State Inspector of Health in a moderately advanced stage of tuberculosis. The man realized that the work was bad for him, but could not see his way clear to give it up, as he had a family to support. Consequently his machine was connected with a fairly efficient exhaust arrangement, and he was separated from his fellow workers by a canvas partition containing an isinglass window. In addition to these precautions he wore a moist sponge over his mouth and used a large jar as a receptacle for sputum.

The workmen polishing brass complained of frequent suffering from headache, dizziness and nausea, and several were annoyed by blue discolorations of the skin and small irritating ulcers which healed with difficulty. An examination of many of the brass workers showed them to be pale and emaciated. Their teeth were in bad condition, and the gums revealed a distinct bluish discoloration. Some of the workmen, on the other hand, notwithstanding the lack of dust-removal appliances, who had been at the work of polishing and buffing for ten or fifteen years, looked robust and healthy.

A careful inspection of some 40 establishments by the State Inspector of Health disclosed the following facts: (1) that some employers are unwilling to install, and operate efficiently, dust removal systems, on the ground that the dust is not "injurious to health," that no efficient means have been discovered for the satisfactory removal of dust, and that all such appliances interfere with the work; and (2) that in some establishments the suction

pipes and hoods were so clumsily arranged as to interfere with the work, and the exhaust fans were not in operation. Employers who had efficient dust-removal systems in operation, however, stated that they would not operate polishing and buffing machines without them. Furthermore, these employers showed the inspector how, by means of a simple contrivance, the hoods could readily be adjusted for different sized castings.

That in some instances both employer and employee are ignorant of the danger arising from the inefficient removal of dust there is no doubt; on the other hand, in many cases the workmen themselves are largely responsible, by their lack of appreciation of and even opposition to properly equipped machines, which, of course, furnishes to the employer from his point of view justification for not operating a system which was installed, perhaps at a big expense.

In the 44 establishments visited, the total number of employees was about 2,000, although the number employed in polishing and buffing was about 150.

For convenience, the factories visited may be roughly divided, from the standpoint of the efficiency of removing the emery, metallic and cotton dust generated in the process of polishing and buffing, into three groups: —

Group A. — Factories wherein exhaust fans, suction pipes and hoods were provided for the emery and buffing wheels and wherein the removal of dust was efficient.

Group B. — Factories wherein dust removal equipments were installed but were found out of order or inefficient. In some instances the hoods were removed, the suction pipes plugged up and the exhaust fans not in operation.

Group C. — Factories wherein no provisions were made for the removal of dust.

Group A. — In 17 establishments the polishing and buffing wheels were covered with hoods and connected with suction pipes and exhaust fans. In 7 of these the removal of dust was highly efficient, in 10 it was moderately so, a considerable quantity of dust from the buffing wheels falling on the floor and on the workmen.

Group B. — In 6 establishments it was found that dust-removal systems had been installed but were inefficient. In 3 of these establishments the systems were in operation, but the dust was not well taken care of, the suction pipes were more or less stuffed up with cotton dust, and in 1 the fan was not large enough to remove the dust. In the other 3 establishments the exhaust systems were not in operation, the pipes were broken and the hoods removed.

Orders requesting compliance with section 1, chapter 475, Acts of 1903, were issued to those in charge of all 6 establishments. Three of the exhaust systems were since put in working order. One proprietor installed a complete new system, which effectively removes the dust. Conditions in this factory were vastly improved. Two establishments have not been reinspected.

Group C. — In 21 establishments the polishing and buffing wheels were not connected with exhausts and conditions varied greatly. In some factories there were great quantities of dust. Some men were found working on emery wheels which generated a fine cloud of emery and metal dust. Standing a few minutes near a worker caused an irritation of the nose and throat. Buffing wheels not connected with exhausts gave rise to great quantities of dust, completely covering the workmen. The floors and walls around the machines were thickly covered. In several places the work was so light that there was little dust.

Orders requesting compliance with the law were issued to those in charge of 16 of the 21 establishments. Exhaust fans, suction pipes and hoods have since been installed in 6, greatly improving the conditions. Five employers are in the process of installing efficient dust-removal equipments, while in 1 establishment the owner decided to discontinue that part of the work rather than install a blower system.

Four establishments have not been reinspected.

In 5, no orders were issued, for the following reasons: —

In each of 2 establishments there was only one small wheel in operation; the work was light and not continuous, giving rise to little dust.

In 2 other establishments the machines were operated by the owners themselves, who had no hired employees. Work was scarce and irregular.

In 1 there were a number of emery wheels scattered throughout the factory. The wheels were not in continuous operation and were used by different workmen for short periods at a time. The work was on large pieces, which would render hoods impracticable.

The light and ventilation in all these factories were on the whole fairly satisfactory. Proper and sufficient water-closets were provided. In 1 establishment the closet was rather dark, and in compliance with a suggestion from the State Inspector of Health a translucent glass window was put into a wall, thus getting light from the hallway. The objectionable habit of spitting on the floor was observed in most of the places visited.

Written orders were issued requiring the installation of proper sputum receptacles in 27 establishments, and it was found on reinspecting 23 of the establishments that the orders had been complied with.

In 10 establishments orders were issued requesting the installation of a first-aid outfit. In 8 establishments reinspected the orders had been complied with.

Several of the establishments showed commendable conditions in all respects, and in 1 the conditions were excellent. The workrooms were high studded, light and well ventilated. Ceilings and walls were white and clean. The floors were very clean and numerous sputum receptacles were distributed throughout the factory. Conspicuous signs were posted in every room which read: "Disease is spread by careless spitting. Tobacco spit is as dangerous as any." A special arrangement was provided for the daily cleansing of sputum receptacles.

VI. Numerical Data.

Number of factories inspected,	182
Number of inspections made,	270

Orders issued: —

Cleanliness,	11
Ventilation,	8
Light,	2
Dust-removal appliances,	18
Sputum receptacles,	41
First-aid outfit,	15
Proper water-closets,	4
Whitewashing,	2

Orders complied with: —

Cleanliness,	11
Ventilation,	8
Light,	2
Dust-removal appliances,	11
Sputum receptacles,	36
First-aid outfit,	10
Proper water-closets,	4
Whitewashing,	2

VII. Health of Minors in Factories.

No systematic examination of minors was made. In 5 candy factories the minors were examined and were found in good health, except for caries of the teeth.

One minor, sixteen years of age, was found suffering with tuberculosis. He was employed in a bakery as packer of ice-cream horns. The attention of his parents was called to his ill health, and he was taken out of the factory and placed in one of the camps near Boston. He is doing well; he has gained in weight; the tubercle bacilli have disappeared from the sputum and he will be able to take up work again in a short time. He was advised to look for work which will keep him out doors.

Another minor of seventeen, working in a clothing factory, was found ill with tuberculosis. This minor had no parents or relatives in this country. He was advised to give up his work and put himself under treatment. Although a suitable case as far as his physical condition is concerned, he was refused admission to the Rutland State Sanatorium because of non-citizenship. He was referred to some relief agencies, who sent him to a private sanatorium in Rutland, where he stayed several months with improvement in his condition. He has returned to Boston, where he expects to take up some out-of-door work.

VIII. Seats for Women in Mercantile Establishments.

Three mercantile establishments were visited to investigate complaints that there were not sufficient seats provided for their women employees. Attention was called in every instance to section 41, chapter 106, Revised Laws, and the conditions were remedied.

IX. Diseases Dangerous to the Public Health.

All cases of diseases dangerous to public health reported from tenement workrooms were investigated, the premises were visited and whenever necessary the licenses were revoked. The number of cases investigated were as follows: —

Diphtheria,	18
Scarlet fever,	8
Measles,	10
Chicken pox,	1
Tuberculosis,	6

The attention of the boards of health in the district was called to premises vacated by tubercular patients, who had either moved or entered into private sanatoria, and recommendations were made that such premises be disinfected. Eighteen such disinfections have been made by the board of health of Boston, 2 by the board of health of Chelsea, and 3 by the board of health of Revere.

A small outbreak of typhoid fever in a trade school in Boston was investigated and reported upon in January.

An investigation was made of an unusually large number of cases of diphtheria that occurred in Chelsea. The conditions found were reported in detail to the State Board of Health in March.

The following matters outside of the district were investigated upon request: —

A suspected case of smallpox was seen with the board of health of Quincy. The case appeared to be a severe case of varicella. This diagnosis was confirmed by the subsequent history.

A suspected case of trachoma was seen with the board of health of Hudson. A diagnosis of follicular conjunctivitis was made; the child was taken to the Eye and Ear Infirmary for treatment.

An investigation was made of the occurrence of 2 cases of poliomyelitis in one of the summer hotels in Gloucester among the maids waiting at the tables. The findings were reported to the State Board of Health.

An investigation was made of the occurrence of typhoid fever in Marshfield, in a house which emptied its sewage on the clam flats. The local board was advised as to steps to be taken to guard against the spread of the disease, and a detailed report was submitted to the State Board of Health.

X. Hygiene of Schoolhouses.

During the year 10 schoolhouses have been inspected, as follows: Roxbury, 1; Charlestown, 1; Revere, 4; and Winthrop, 4.

In January, 1909, at the request of the principal the Roxbury Latin School was inspected. It was found that during the cold weather, when all the windows were closed, the ventilation of the classrooms was not good. Some simple means of improving conditions, such as window ventilators and periodical opening of the windows, have been found impracticable as it took out too much of the heat. The only way which seemed possible to improve conditions would be by a new heating and ventilating system, which cannot now be installed for lack of finances, as it is an endowed school. Suggestions were also made to improve the light in the toilets by translucent glass panels in the doors. This has been done.

All the other schools were inspected during the spring, and a detailed report of each schoolhouse was submitted to the State Board of Health. Conditions as to light, cleanliness and toilet provisions were found satisfactory in all the schools visited. The heating and ventilating systems were similar in all the schoolhouses. Cold air from the streets is heated by steam coils, rises through flues and enters the classrooms through inlets placed near the ceiling. Outlets for the foul air are placed near the floor in the same wall with the inlets. These outlets open into ventilating stacks which are carried to the roof. Aspirating coils are placed in these stacks. In some of the schools these aspirating coils are heated by separate boilers, so that these can be heated even when no heat is furnished to the building. In others the coils are heated by the same boilers which furnish heat to the building. In 1 school in Revere the ventilation was inadequate. There were no aspirating coils in the ventilating stacks, nor was there any other means of causing a circulation of the air. The teachers have stated that the rooms are poorly ventilated, and that a short time after the session begins the rooms feel stuffy and the children become fidgety, so that it is necessary to open the windows to admit fresh air.

While as a rule the ventilation of the schoolhouses inspected may be quite satisfactory during the cold weather, when hot air is admitted to the rooms, it is inadequate on those days when the buildings are not heated and when it may be too cold to open the windows. On the day, for instance, when the Charlestown High School was inspected, the building was not heated and most of the windows were closed, the ventilation of some of the rooms being inadequate. The air of several of the rooms where pupils were taking examinations felt stuffy and was so impure as to be injurious to health. Now in this school the air is forced into the rooms by a ten-foot fan, but this fan, as well as the aspirating coils in the ventilating stacks, are operated by steam from the same boiler which heats the building, so that on days when the building is not heated the fan is not in operation nor is there any heat in the ventilating stacks. This condition could have been remedied by having a small boiler for

operating the fan and heating the aspirating coils, so that a good circulation of air could be had even on days when the building is not heated.

Another point worthy of mention is the absence of sanitary drinking fountains in the schools. Only in 1 school were such fountains observed. The old-fashioned drinking cup, in spite of the well-recognized dangers of transmitting disease through it, was still in vogue. In the Charlestown High School the principal does not permit the use of a common cup, and the pupils have to provide individual cups. This is not done to any extent for the water in the building is not fit to drink on account of the close proximity of the steam pipes to the water pipes, making the water tepid as it comes from the faucet.

XI. Local Nuisances.

Conditions found.	*Action taken.*
A nuisance consisting of an overflowing cesspool and faulty drains at a house on Ocean Avenue was brought to the attention of the board of health of Revere.	House has since been connected with the sewer. Nuisance abated.
A complaint of a nuisance consisting of dumping of swill on a vacant lot in Revere was investigated in September. At the time of inspection there was no evidence of the conditions complained of. It was stated that the nuisance existed only during the summer months.	No action taken.
A nuisance of an overflowing cesspool at Parker Hill Avenue, Roxbury, was investigated, and conditions were reported to the State Board of Health.	New cesspool was constructed and nuisance abated.
The attention of the Boston board of health, also of the Boston sanitary department, was called to a nuisance consisting of neglected garbage barrels.	Nuisance abated.
A nuisance caused by a gypsy camp in Newton was investigated and a report made to the State Board of Health.	Matter was taken up by the State Board of Health.

Health District No. 6.

Albert P. Norris, M.D., *Cambridge, State Inspector of Health.*

This district includes the cities of Cambridge, Everett, Malden, Medford, Melrose and Somerville, and the towns of North Reading, Reading, Stoneham and Wakefield.

Diseases Dangerous to the Public Health.

The following outbreaks of diseases dangerous to the public health were investigated: scarlet fever in North Reading, typhoid fever in Wakefield,

scarlet fever in Melrose, anterior poliomyelitis in Malden and Melrose, typhoid fever in Everett, and typhoid fever in Cambridge and Somerville.

The State Inspector of Health observed an increasing tendency in each city and town within his district toward complete registration of persons ill with tuberculosis. Twelve persons ill with the disease were visited, six of whom were referred to hospitals or dispensaries for treatment.

Local Nuisances.

The State Inspector of Health reported that one manufacturing concern in Wakefield persisted in polluting the Saugus River by pouring into it the sewage from its factory.

The attention of the Reading board of health was called repeatedly to the necessity for a sewer in that town, because of overflowing cesspools and polluted soil. Drainage from a laundry near the center of the town is conveyed by a brook into Lake Quannapowitt, which, at certain seasons of the year, is the water supply of Wakefield. Until a sewer is constructed the existing nuisance will remain a possible source of danger to the health of Wakefield residents, as well as to the users of the ice supply. The town of Wakefield has been warned not to use the water supply because of the probable impurity of the water.

Several nuisances were abated in Stoneham by inducing abutters to connect with the town sewer. Large cement settling tanks were installed in a tannery which had previously polluted the Aberjona River, and the spent liquors are now carried off by a recently constructed sewer, so that the quality of the river water is much improved. Both town water and sewerage system were extended to the Healey Brothers' shoe shop. With the aid of the State Inspector of Health a piggery nuisance was abated. The local board of health took active measures to abate the odor nuisance arising from a glue establishment maintained near the Woburn line, and the State Inspector of Health advised said board to co-operate with the Winchester and Woburn authorities in remonstrating against the construction of another glue establishment in that locality, which is now built up with suburban residences.

The outlet of Spot Pond, running through a thickly populated community, was badly polluted by overflowing cesspools from three abutting premises. With the aid of the State Inspector of Health the Melrose board of health brought about a connection with the sewer.

Several overflowing cesspools and private water supplies were investigated in the Maplewood and Linden districts of Malden, where many cottages are built on steep ridges. Sewer extensions are contemplated in these localities as soon as they can be financed.

Four nuisances consisting of overflowing cesspools in the upper Broadway district in Everett were brought to the notice of the State Inspector of Health. This district has grown rapidly and is densely inhabited. One and two family houses are located on small lots, which are entirely inadequate in area for the proper use of cesspools. The local board of health has been

urged repeatedly to require a sewerage system in this district, but up to the present time the city government has failed to make the necessary appropriation.

Complaints in Somerville concerning drainage have related to the auxiliary overflow during severe storms, when sewage backs into the storm sewers which are designed to enter several brooks. After the water recedes the beds of the brooks are rendered unsightly and at times give rise to disagreeable odors. The brooks which give rise to disagreeable conditions are the Clarendon and Tannery brooks, which flow into the Alewife, and the Two Penny Brook, which crosses the Medford line east of the North Somerville station.

A section of lowlands in East Cambridge, and the portion of Somerville known as the Millers River district, and areas in East Cambridge and Cambridgeport, need some system for the proper removal of sewage.

Several rendering works in Cambridge were inspected, with a view of aiding so far as possible obnoxious odors therefrom, and it was found that bones and scraps were not collected and cared for in a proper manner. The attention of the local board of health was called to the matter.

A rendering establishment in Somerville was inspected and it was found that suitable and efficacious hoods, suction pipes and blowers were installed. Once in eight minutes there is an interchange of air throughout the establishment, the foul air being taken upward through a tower 65 feet high. Notwithstanding the excellent provisions designed to remove the objectionable odors an inefficient use of the same is made.

Factory and Industrial Hygiene.

Sugar Refinery Establishment. — Employees in this establishment were found to be exposed to excessive heat and steam of "bone black" dust. As to the sugar dust itself, men were found who had worked from twenty to forty years without apparent detriment to their health. Only 5 minors were employed.

Confectionery Establishments. — All the factories visited were found to be well lighted and adequately ventilated. Large numbers of minors were employed in this industry attending machines, dipping chocolates and assorting and packing boxes. The girls were generally found sitting down while at their work. The only general condition of ill health noted among them was decayed teeth, and individual instructions relative to the condition of the teeth were given many of the minors, some of whom it was found on later visits to the factories had consulted dentists.

Distilleries. — The 4 distilleries within the district were inspected and it was found that great care was taken to provide for the liberation of large amounts of CO_2 gas in the fermentation rooms.

Knitting Mills. — The 7 knitting mills within the district were inspected and were found to be, in general, well lighted and adequately ventilated. These establishments employ large numbers of minors, who are exposed to lint from linen and cotton in the winding and braiding departments. The

State Inspector of Health was of the opinion that the minors showed a tendency to an anemic appearance and to frequent colds. No minor was found to have symptoms of tuberculosis. In the silk department, where the dust seemed especially irritating, 2 adults were found who had apparently recovered from previous tubercular conditions.

Manufacture of Wearing Apparel. — There are 10 shops within the district which use power sewing machines in the manufacture of wearing apparel. In general, the light was found to be good and the ventilation adequate. The women sitting at benches worked rapidly and under tension at piece work. While eye strain was occasionally manifested, the women seemed to the State Inspector of Health to be more often tired and nervous and to have a strained appearance.

Printing or Finishing Textiles. — The 6 establishments in which printing or finishing textiles was conducted were inspected. Examples of distinctly good and distinctly bad hygienic conditions were found in this industry. The "aniline black" process is accompanied with liberation of considerable amounts of HCN, and occasionally an employee in this department is said to be prostrated by the inhalation of fumes, although in every factory hoods and suction flues were installed for the removal of the gas.

Manufacture of Rubber Goods. — The manufacture of rubber goods is one of the leading industries in the district. More than 4,000 employees were found in the 8 factories visited. The most important factor in connection with the health of the employees was, in the opinion of the State Inspector of Health, the "strong odor" of naphtha used in the cements. The importance of this factor is better appreciated when it is understood that superintendents and overseers want the windows closed in order to avoid evaporation of the naphtha. One establishment has installed a pump and pipe line from their cement house outdoors, so that cement is drawn from a tap by the employee instead of dipping it out of large jars. One factory experimented with a siphon ink-well cup, to be used at the "maker's bench" to prevent much evaporation of the naphtha, hence to permit better ventilation in the rooms. Large quantities of whiting dust filled the air in the so-called "calendar and incorporating machine rooms." In 1 establishment this dust was especially noticeable. In a department where employees are occupied in removing wire from circular boxes of whiting in which the wire is heated, the dust rises in clouds. While the employees in this department were adults, the process was, in the opinion of the State Inspector of Health, necessarily inimical to health.

Allied to the manufacture of rubber goods is that of rubber substitutes. In this work quantities of amyl acetate were found to be used as solvent of the substitute mixture. In the drying out process the employees were exposed to very strong fumes of amyl acetate. Although 2 men of three and five years' exposure to amyl acetate fumes showed no signs of ill health, an employee thus exposed in the lacquering department of a jewelry establishment became debilitated and contracted tuberculosis.

Laundries. — The laundries inspected were well lighted and adequately ventilated. One laundry was a model establishment. In another, improvements were suggested and made relative to light and ventilation.

Printing and Binding Establishments. — One modern printing establishment was exceptionally well lighted and ventilated. Only one bench where 10 girls were employed used artificial light. The work of the girls consisted in assembling folios. In this establishment was a room for outside wraps of employees, a lunch room, a lounging room and an emergency outfit. Another large establishment was very well lighted and adequately ventilated. Several small printing establishments installed additional ventilating flues and fans at the suggestion of the State Inspector of Health.

Manufacture of Boxes and Trunks. — The paper box establishments within the district are, as a rule, in old buildings. The departments for working on wood were found to contain machines equipped with devices for removing shavings. Some changes were suggested by the State Inspector of Health relative to the lighting arrangement in several establishments. The conditions in 1 factory relative to light, ventilation and the removal of dust were quite satisfactory. All the employees appeared to be healthy.

Manufacture of Furniture. — There are 15 furniture factories within the district, for the most part old structures. The woodworking department in 1 establishment was well equipped as regards light and ventilation. The processes known as rattan splitting and sorting, however, were exceedingly dusty, and, in the opinion of the State Inspector of Health, necessarily irritating to the respiratory passages of the employees. Three cases of tuberculosis occurred among young adults working in this department. One of these employees took out-of-door treatment at home and the other 2 in sanatoria. A furniture factory visited in Cambridge was found to be well lighted, except for one department known as the milling room, which occupied the basement and was lighted by artificial means. The largest number of employees in furniture factories are adults. Fifteen factories, other than those mentioned, in which woodworking processes of some kind were conducted, were inspected, and it was found that each establishment was equipped with devices for the removal of fine sawdust. One establishment in Malden was particularly well lighted and adequately ventilated. The employees were mostly adults who showed no ill effects from their work.

Carriage Factories. — Of the 5 carriage factories visited, 1 in Medford was constructed of cement and provided with a monitor roof and exhaust fans and hooded forges.

Piano and Organ Factories. — The 9 organ and piano factories within the district, employing about 1,000 persons, were inspected. Large numbers of minors were found to be employed in the manufacture and assembling of the actions. This work, which was of a sedentary nature, consisted of planing, sawing, drilling and sandpapering the parts. Several cases of debility were found among the minors, one of whom, a boy, disclosed signs and symptoms of tuberculosis. It should be said, however, that this boy's

home conditions were distinctly bad, in that the boy slept in a small, badly ventilated bedroom. One piano factory was especially well provided as to light, ventilation and means for the removal of dust.

Manufacture of Brushes. — The 6 brush factories within the district, employing about 250 persons, were inspected. One factory located in Malden was exceptionally well lighted and ventilated; the rooms were high posted and hoods were provided in connection with the tar cement process in the department where bristles were attached to brush handles. The manufacture of corn brooms was, in the opinion of the State Inspector of Health, exceedingly dusty work. As conducted in 1 establishment, hooded machines were provided with a chamber for the removal of dusts, seeds and other foreign material. In another establishment, the so-called "wet process" was adopted, whereby the brooms were wet before the seeds and dust were removed.

Manufacture of Pharmaceutical Preparations. — There are 5 factories within the district wherein pharmaceutical preparations are made. Each establishment was visited, and it was found that in the process of grinding roots and herbs employees frequently wore respirators. In one instance, grinding of this kind was conducted in a shed outside the building, and the employees who did the work appeared to be exceptionally strong.

Manufacture of Chemicals. — Factories in which chemicals are manufactured were found to employ many minors, a part of whose work it was to put up the packages for retail trade. A small number of men worked in the chemical departments. Except for the dark cellars in 1 establishment, where an employee was found doing the heavy press work of making insulating coverings for electrical utensils, all the establishments appeared to be well lighted and adequately ventilated.

One large establishment appeared to the State Inspector of Health to be the most obnoxious within the district from the point of view of the health of the employees. Quantities of fumes were liberated at each step in the manufacture of such commercial acids as H_2SO_3, H_2SO_4, HCL, HNO_3, etc. So long as the plant remains isolated the fumes cause little disturbance in the neighborhood, although nitric oxide, sulphurous and sulphuric anhydride fumes escape at times in considerable quantities. The State Inspector of Health observed that the rugged laborers employed in the establishment appeared to become accustomed to fumes which might cause various disturbances among beginners. Each building was constructed like a shell, with ventilating windows in the roof.

Soap Making. — The 10 soap works within the district, with and without rendering departments, were inspected. The sanitary conditions in 1 establishment were practically ideal. Those in another establishment were satisfactory, except that the kettle rooms were too low posted, and consequently not well lighted and ventilated.

Leather Working. — Hides were found to be treated in 3 establishments by salting and sorting in cold cellars, and in 3 others by removing the hair

and wool. Employees who handled the Na_2S were furnished with rubber gloves.

Manufacture of Shoes and Leather Goods. — The 12 shoe and leather factories within the district were visited. In several of the large establishments the number of employees in the stitching and making departments was so great that a further increase should be met by forced ventilation. A common unhygienic arrangement of water-closets was that of locating the closet in the center of the workroom, with no outside ventilation.

Foundries. — All the 11 foundries within the district were inspected. In 2 establishments the conditions from a sanitary point of view were especially good. The process of screening sand in order to recover a portion for future use gave rise to the scattering of much fine sand through the air. In 1 establishment the sifting processes were hooded in connection with the use of ash sifters, while in 2 other establishments these processes were conducted in separate departments. In general, only men were found employed in foundries, but in 1 establishment Polish women made cores and the smaller moulds. In another foundry, in a separate department, some 60 girls were employed, seated at well-lighted benches well screened from the foundry proper.

Metal Working Establishments. — Thirty-six metal working establishments were found and inspected within the district, ranging from shops manufacturing specialties to constructive planes making steel bridges, engine boilers, etc. One establishment deserved especial commendation from a sanitary point of view. As a rule, good light, being an essential factor, was provided. Emery wheels most frequently used have been equipped with proper dust appliances for protecting workmen against dust in all the establishments. In 6 establishments the processes of tin and zinc dipping were conducted. One establishment was equipped with a well-ventilated tinning bath and a large chimney which conducted the fumes from the bath. In another establishment the arrangement was such that the fumes of ammonium chloride, heated, and zinc oxide powder appeared to rise rapidly in dry, clear weather, but slowly on dull, wet days. In still another establishment the experiment of using an exhaust fan and wooden duct and hood over the tinning bath was made. About half the number of establishments visited were equipped with ventilating fans in the roof.

Manufacture of Jewelry. — The 4 jewelry establishments within the district were inspected. The processes conducted which appeared to the State Inspector of Health to be of greatest importance were those of soldering, plating and lacquering. In the soldering department the blue flame of the Bunsen burner was continuous, although such rooms were generally well ventilated by ducts and opened windows. The plating rooms were provided with hoods and suitable stacks. The process which appeared to be most inimical to health was that of lacquering, which gave rise to strong odors of amyl acetate. In 1 establishment there was provided a separate, fireproof, monitor roofed building for this purpose. While the power fans and

ducts in this building were designed to bring about good ventilation, the State Inspector of Health found the exhaust system working adequately only one time in the course of his four visits.

Glass Blowers. — In the 1 establishment manufacturing electric bulbs 40 girls were employed in darkened rooms as glass blowers. The work was constant, and the girls were exposed continuously to the blue flames of the Bunsen burner. Another establishment employed minors to help in the glass blowing departments. Because of the nature of the work the minors were exposed to excessive heat. In the cut glass department the process of wet grinding was conducted by a considerable number of aged men.

The Lead Industry. — In 1 establishment in the manufacture of white lead the State Inspector of Health pointed out that in the department where chemicals were circulated in solution through pots of feathered lead, only 1 or 2 employees worked. It is said that no case of lead poisoning has occurred among employees in this establishment for several years. In another establishment in a department where lead grids were cast and the spaces filled with a paste made from carefully sifted litharge, 2 minors were found to have contracted lead poisoning.

Health of Minors in Factories.

Total number of minors seen and questioned, 2,090.

	Age.							Total.
	14	15	16	17	18	19	20	
Male, ...	36	93	143	196	209	187	143	1,007
Female, ...	41	138	184	116	229	202	173	1,083
Total, ...	77	231	327	312	438	389	316	2,090

Total number of minors found in ill health, 106.

	Age.							Total.
	14	15	16	17	18	19	20	
Male, ...	4	11	10	10	11	5	8	59
Female, ...	–	5	8	10	10	4	10	47
Total, ...	4	16	18	20	21	9	18	106

Number of physical examinations made, 290: —

Because of tubercular family history, ...	66
Because of previous personal history, ...	69
Because of appearance of minor, ...	155

Five notifications to parents were made relative to the ill health or physical unfitness of minors. In two instances employers were notified of the ill health of minors, to the advantage of the latter. One minor was given better accommodations for desk work, the other was assigned lighter work.

Classification of Conditions of Ill Health of Minors. — Among the conditions of ill health found in persons under twenty-one years of age were the following: —

Bronchitis,	38	Rhinitis,	1
Anemia,	16	Chorea,	1
Chlorosis,	6	Cataracts,	1
Laryngitis,	5	Eczema,	1
Decayed teeth,	4	Furunculosis,	1
Conjunctivitis,	3	Mammitis,	1
Mitral insufficiency,	3	Nephritis,	1
Phthisis,	2	Scarlet fever,	1
Nasal obstruction,	2	Strabismus,	1
Suppurating ear,	2	Malformation,	1
Adenoids,	1	Chronic headache,	1
Pleurisy,	1	Enlarged cervical glands,	3
Tonsillitis,	1	Kyphosis,	1

Twenty-five of the minors found in ill health were exposed to possible unhygienic influences in the following processes: —

Manufacturing confectionery.
Rubber cementing.
Core making.
Talc dusting on rubber.
Nickel plating.
Woodworking.
Sandpapering.

Schoolhouse Hygiene.

Thirteen school buildings were inspected during the year.

The buildings were heated either by furnaces or by indirect steam radiation. Ventilating flues were found in most of the school buildings, but in many of them there was no heating apparatus in the flues to facilitate ventilation. The majority of these flues were inadequate, and as a result the schoolhouses were poorly ventilated. Overcrowding was observed in many of the schoolhouses visited. The best modern ventilating system was found in the Cambridge Latin Schoool, while the most efficient means of ventilation in the older school buildings was in the Prescott schoolhouse in Somerville, which was equipped with a modern ventilating or forced draft system. Throughout the district it was noted that the rooms occupied by the lowest grades of pupils in school buildings erected more than twenty years ago were stuffy and poorly ventilated. The State Inspector of Health believed that the common factors which gave rise to such conditions were increased numbers of children and the sensitiveness of children to drafts, which caused the teachers to keep the windows closed.

The Thorndike School building in East Cambridge, erected in 1860 and remodeled in 1876, was, in the opinion of the State Inspector of Health, so badly ventilated and overcrowded as to be unfit for use without alterations.

Somerville has been progressive by installing drinking fountains in nearly every school building, thus doing away with the common drinking cup with its possible dangers.

Health District No. 7.

J. William Voss, M.D., *Beverly, State Inspector of Health.*

This district includes the cities of Beverly, Gloucester, Lynn and Salem, and the towns of Danvers, Essex, Hamilton, Ipswich, Lynnfield, Manchester, Marblehead, Middleton, Nahant, Peabody, Rockport, Saugus, Swampscott, Topsfield and Wenham.

Diseases Dangerous to the Public Health.

Aside from an epidemic of dysentery, which occurred in the city of Beverly during the month of August, the number of cases of infectious diseases has not been unusual.

Consultations with Local Boards of Health.

Frequent consultations were held with members of local boards of health with special reference to reporting diseases declared by the State Board of Health to be dangerous to the public health and to methods used for the prevention of the spread of such diseases.

Local Nuisances.

Twelve alleged nuisances were investigated, and such conditions as were found to constitute nuisances called to the attention of the local health authorities, with such recommendations as were deemed advisable for their removal.

Factory Hygiene.

Sanitation of Factories. — One hundred and eighty-three factories were visited, — 1 for the fourth time, 18 for the third time and 139 for the second time. The number of orders issued and complied with were as follows: —

For improved ventilation,	6
For a higher degree of cleanliness,	12
For more efficient removal of dust caused by certain processes,	9
For proper water-closet provisions,	46
For first-aid outfits,	17
For the provision of sputum receptacles,	83
For the connection of a factory with the public sewerage system,	14

Ventilation. — It was observed during the winter months that many of the windows in factories were required to be opened during the noon hour and in the early morning. In 1 mill manufacturing hosiery provision was made at the top of the windows to allow the entrance of fresh air. The superintendents were instructed to keep the establishment well ventilated. Moreover, a physician was employed by the corporation for the purpose of having a sanitary supervision over the buildings.

Removal of Dust. — It appeared to the State Inspector of Health that the problem of adequately protecting the employees against dust generated in the course of manufacturing processes was not receiving the attention of the designers of dust-removing devices that its importance demanded. Some of the manufacturers showed especial interest in the matter by providing machines with dust-removing devices which previously had not been equipped with any means for protecting the workmen against dust. In 1 establishment the removal of mica dust was found to be a difficult problem, and much money was spent towards its solution. The industry is now conducted in a new establishment with an entirely new equipment, which appears to be adequate in every respect. The Salem and Beverly boards of health, acting upon recommendations of the State Inspector of Health, formed regulations prohibiting the blowing of buffing dust into the open air, and requiring proper receptacles for its retention, thus preventing the dust blowing back upon the panes of glass and interfering with the light or entering the open windows.

Light. — In all the new buildings inspected the light was found to be excellent. This was accomplished by saw toothed or hipped roofs and the use of ribbed glass, and by numerous windows so constructed as to extend to the top of the room.

Water-closets. — Thousands of dollars were spent by employers to improve the water-closet provisions in factories. In 1 establishment alone 20 new closets were built. In a shoe factory in which the closets were not provided with ventilating provisions $300 was spent for ventilating the closets. In one town where the most of the manufacturing establishments were provided with unsanitary closets, proper closets were constructed in nearly every establishment and connection was made with the sewer. In a large establishment where 1,000 persons were employed, because of the difficulty in keeping the closets in a sanitary condition a man was employed, at a salary of $800, for the sole purpose of maintaining cleanliness. In a new establishment where 50 water-closets were found in an unsanitary condition a man was later employed to keep them clean. The State Inspector of Health observed that the older and poorly constructed factories required constant inspection in order to maintain a decent standard of cleanliness.

Receptacles for Expectoration. — The State Inspector of Health noted that the most of the factories within his district were supplied with receptacles for expectoration. He pointed out the fact that in many instances the receptacles were not properly cared for. In some establishments the workmen

cleaned them. In 1 large establishment each workman was required to pay 25 cents for a receptacle when he entered the factory and when he left the employ of the firm the money was refunded. It appeared that a number of employees discontinued the use of tobacco rather than take care of the receptacles. Some of the workmen refused to clean them. It appeared that the paper receptacles were easily broken and readily overturned, and that their use was objected to by some of the insurance companies. Moreover, they were often allowed to remain without renewal long after their use should have been discontinued.

First-aid Outfits. — All the factories are now provided with surgical and medical appliances, in accordance with chapter 164 of the Acts of 1907. One large establishment maintains a well-equipped first-aid hospital, with a trained nurse in attendance. Another large establishment is building a first-aid hospital and is about to employ a suitable person for first-aid work.

Health of Minors in Factories.

Total number of minors seen and questioned, 1,650; males, 896; females, 754.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	112	186	268	278	34	10	8	896
Female,	61	126	243	241	41	20	22	754
Total,	173	312	511	519	75	30	30	1,650

Number of minors in ill health, 53.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	4	6	15	7	-	-	-	32
Female,	7	1	8	4	1	-	-	21
Total,	11	7	23	11	1	-	-	53

Number of physical examinations made, 585: —

Because of tubercular family history,	21
Because of previous personal history,	2
Because of appearance of minor,	53
Regardless of appearance of minor,	509

Classifications of Conditions of Ill Health.

Anemia,	14
Adenoids,	21
Organic disease of heart,	2
Organic disease of heart with good compensation,	4
Curvature of spine,	1
Pre-tubercular,	7
Convalescence from pneumonia,	1
Contagious skin disease,	1
Abscess of jaw,	1
Tobacco heart,	2
Pleurisy,	2
Total,	56

With the exception of those minors who were working in stitching and finishing rooms of shoe factories, where naphtha, cement and wood alcohol were used, the conditions under which the work was done were favorable for health.

Schoolhouse Hygiene.

During the spring 13 schoolhouses were inspected, distributed as follows: Beverly, 9; Peabody, 3; Salem, 1.

Detailed reports of the conditions found were submitted to the State Board of Health.

In 11 of the schoolhouses there were gravity ventilating systems. While in some the systems were fairly satisfactory, in several schools they were inefficient. In 1 schoolhouse the ventilating system depended for its efficiency on the general heating system. When the inspection was made the building was not heated and the ventilating flues were of no use.

Two schoolhouses depended entirely on window ventilation, which was inadequate. The quantity of carbon dioxide in the air of the schoolrooms varied from five parts to 10,000 parts of air in the rooms where the ventilation was adequate to 14 parts in 1 schoolroom which depended entirely on window ventilation.

The toilet facilities were adequate and satisfactory in all the buildings with the exception of 1, where old-style privies were provided where good sanitary conditions could not be kept up.

Light was as a rule satisfactory, the light coming from the rear and left or from the rear and two sides.

In 1 classroom the light came from the left and front. This could be easily remedied by rearranging the seats.

In another classroom the light came from the side and front, but owing to the peculiar shape of the room it would be difficult to rearrange the desks. On dark days artificial light had to be used in this room.

The cleanliness was found good in all the schoolhouses. The rooms and halls were swept after school hours; the sweeping was in the majority of instances done by a wet process, giving rise to a minimum amount of dust.

Tenement Hygiene.

Four hundred and fifty-five licenses were issued for working on wearing apparel. Of this number, 169 were issued during the present year. The people who did the work lived, in the main, in homes where the sanitary conditions were good.

Health District No. 8.

William Hall Coon, M.D., *Haverhill, State Inspector of Health.*

This district includes the cities of Haverhill, Lawrence and Newburyport, and the towns of Amesbury, Andover, Boxford, Georgetown, Groveland, Merrimac, Methuen, Newbury, North Andover, Rowley, Salisbury and West Newbury.

Conferences with Local Boards of Health.

Amesbury. — At the request of the State Inspector of Health the Amesbury board of health passed upon the form, construction and number of receptacles for expectoration in factories, in accordance with the legislative requirement of 1907.

The State Inspector of Health suggested to the board the advisability of requiring a negative culture or cultures in all cases of diphtheria before release from quarantine, and by vote of the board two negative release cultures are now required.

At the request of this board the State Inspector of Health investigated a nuisance located on Pearl Street, which resulted from the lack of a sewerage system, the discharge of sewage matter emptying into an open brook. Conference concerning this matter was held with both the board of health and the selectmen, who, acting in conjunction, caused the nuisance to be remedied.

The State Inspector of Health suggested to the board that, as Amesbury was not provided with a proper system of sewerage, the greatest precaution should be taken in the disposal of dejecta from all cases of typhoid fever occurring in the town. The board now makes this precaution the subject of inquiry in each case of typhoid reported. The board has also issued and distributed circulars relative to this disease.

Assistance was given the board concerning a nuisance at the local gas plant, caused by the improper disposal of waste matters, and the board issued an order which provided for its abatement.

Andover. — The State Inspector of Health recommended that the board require in all cases of diphtheria one or more negative cultures before releasing from quarantine. No action was taken by the board, on the ground of impracticability.

On complaint of certain citizens of the town the State Inspector of Health investigated the conditions existing in a dwelling occupied by individuals ill

with tuberculosis. In this dwelling were found, living among the most destitute and miserable surroundings, a young girl of sixteen, evidently tubercular, a mother in the terminal stage of pulmonary tuberculosis confined to her bed, and an aged and infirm grandmother. The mother expectorated on the bed clothes, the floor or any other convenient place. The girl attended a local school and was referred to the school physician for examination. She was found by this physician to have pulmonary tuberculosis in a moderately advanced stage.

The facts were presented to the local board of health and immediate action was taken in the premises. The father was committed as a vagrant to a State institution and the other members of the family were given necessary assistance and advice. The mother lived but a short time, but the girl has been under the care of the Andover Society for the Suppression of Tuberculosis.

Boxford. — At a conference held with the Boxford board of health the State Inspector of Health found that no records of diseases dangerous to the public health had been kept by the board, and, further, that the board had issued no regulations relative to the public health, — cases of communicable disease being released at the will of the attending physician, with the observance of no stated periods of quarantine.

The board now have under their consideration the preparation of suitable health regulations.

Georgetown. — At the request of the State Inspector of Health the Georgetown board of health enforced the statutes relating to the licensing of slaughterhouses in the town, the appointment of an inspector of meats and provisions, and the provision for suitable receptacles for expectoration in factories and workshops.

The State Inspector of Health suggested that the board formulate certain regulations concerning diseases dangerous to the public health, and that they provide for suitable periods of quarantine in the more common of these diseases and require a negative release culture from all cases of diphtheria. These suggestions are now under advisement by the board.

Acting upon a suggestion of the State Inspector of Health because of failure of the physicians to report all cases of diseases dangerous to the public health, the board sent a letter to the physicians, who since then have reported such diseases promptly.

Haverhill. — On request of the Haverhill board of health the State Inspector of Health appeared before members of the city government to suggest the advisability of appointing a bacteriologist to the board, and the proper equipment for a bacteriological laboratory. The office of bacteriologist is now combined with that of inspector of milk, and the officer in charge examines bacteriological specimens free for all physicians in Haverhill.

The State Inspector of Health was consulted by this board in matters relating to the establishment of a hospital for "contagious" diseases, and visits were made with the agent of the board and a member of the municipal council to hospitals in other localities. The accommodations of the Haverhill

City Hospital for the care of diseases dangerous to the public health are unsuited for this purpose. All cases of diphtheria, scarlet fever, measles and tuberculosis are now cared for in shacks, small wooden structures, loosely built and heated by stoves, each building sufficient in size to accommodate only two persons. The interior of each shack is sheathed with a paper preparation which cannot be properly disinfected, yet the best known means of disinfection is called for, since the shacks shelter alternately cases of diphtheria, scarlet fever, measles and tuberculosis, and when not occupied by this class of cases are used for the reception of other cases, alcoholics and the like.

The attention of the board was called to the presence of accumulations of refuse and rubbish in the alley ways of the shoe district south of Washington Street, and the board, through its agent, took immediate and satisfactory action in the premises.

On receipt of complaint from individuals that the discharge of sewage above high-water mark from the sewer mouth at the foot of Main Street was the cause of sickness among members of the crew of the steamer "Merrimac," whose berth was immediately adjacent to the sewer opening, the State Inspector of Health investigated the matter and reported his findings to the board for action. The complaint was finally referred to the municipal council, by whom it was placed on file.

The State Inspector of Health suggested the practicability of a regulation forbidding the delivery of milk in bottles at any house in which a disease dangerous to the public health is known to exist, and such a regulation was incorporated in the milk regulations of the board.

Suggestion was made to the board and to the mayor and members of the municipal council that in certain of the public schools in which each year there have appeared a certain number of cases of "contagious" disease, it would be advisable to substitute for the common drinking cups some form of a bubbling fountain, and that the use of sanitary paper towels be substituted for the towels used in common. One type of bubbling fountain has since been installed in one school, but has been found unsatisfactory; another fountain is to be substituted, and if found practicable will probably be introduced in the other schools.

Lawrence. — In 1908 the Lawrence board of health, at the suggestion of the State Inspector of Health, created the position of bacteriologist and physician to the board. The position remained unfilled, however, until May, 1909, when a physician was appointed to serve three years. A well-equipped laboratory has been provided for the use of this official, who, in addition to his other work, examines bacteriological specimens for physicians free of charge. Since the appointment of a bacteriologist the board has required one negative culture for the release of diphtheria patients.

At the request of the Sanitary Milk Society of Lawrence, an association having for its primary object the reduction of the infant mortality of Lawrence through a proper milk supply, the State Inspector of Health investigated the conditions under which milk was sold in the retail stores of the congested portions of the city. The facts obtained were submitted to the

local board of health, with the recommendation that some means be taken by said board to correct the unsanitary conditions found to exist. After an interval of several months, during which time no action was taken by the board upon the recommendation, the State Inspector of Health again pointed out the need of action. The board then voted to instruct the inspector of milk to license only those stores found to be clean and capable of maintaining cleanliness, and also voted that on and after Jan. 1, 1909, all milk from retail stores must be sold from bottles only.

In 1908 this board made a regulation concerning receptacles for expectoration for factories and workshops, which left to the employers the determination of the number needed in any given establishment. At the suggestion of the State Inspector of Health the regulation was changed so as to provide for a fixed standard for all factories, leaving only the number to be passed upon by the sanitary inspector for the board.

As the result of calling to the attention of the board the fact that evidence was disclosed to show that the physicians of Lawrence were not reporting all cases of tuberculosis coming under their observation, the board sent circulars to the physicians requesting that all cases of tuberculosis be promptly reported, in accordance with the statutes.

In 5 instances the State Inspector of Health was asked to assist in the diagnosis of cases of smallpox and chicken pox.

Merrimac. — Conferences with the Merrimac board of health have been held from time to time and advice given when requested. Although the State Inspector of Health called to the board's attention the need of enforcing the law relative to providing receptacles for expectoration in factories, no action has been taken by the board up to the present time in accordance with a legislative act of 1907 as to the required form, construction and number of such receptacles.

On complaint of a manufacturing concern that an open sewer running in close proximity to their premises was the cause of ill health among the employees, the State Inspector of Health investigated and found this complaint to be well founded. The attention of the board was called to the unhygienic conditions found, with a recommendation that they be remedied. The board after referring the matter to the town solicitor voted to abate the nuisance by converting the open sewer into a closed drain.

Methuen. — Conferences relating to the general work of the Methuen board of health were held from time to time in the presence of the full board. Upon the request of the State Inspector of Health the board made the necessary requirements relative to receptacles for expectoration in accordance with the statute provisions. The State Inspector of Health advised the board as to the adoption of proper quarantine regulations and the requirement of two consecutive negative cultures before releasing from quarantine cases of diphtheria. The board has not as yet adopted the suggestion.

Upon the request of a citizen of the town the State Inspector of Health investigated an alleged nuisance caused by fumes from chemical works. The matter was taken up with the authorities of the chemical works, who caused

the conditions complained of to be so remedied that no further complaint has been necessary. A complaint of inadequate sewerage facilities in the same neighborhood was found to be justified, and the matter was referred to the local board of health with the recommendation that adequate sewerage facilities be provided for the residents of this locality. The board later acted upon this recommendation.

For further recommendations see "Slaughtering and Meat Inspection."

Newburyport. — At the request of the Newburyport board of health an investigation was made of the sanitary condition of the Newburyport police station and several business blocks. An order was issued, and later complied with, for proper water-closets in a mercantile establishment in one of the business blocks. At the same time the attention of the board was called to the unsanitary condition of a bakery. By order of the board this bakery was made sanitary.

Notwithstanding the fact that the State Inspector of Health made several requests to the board that they approve the form, construction and number of receptacles for expectoration in factories, no action was taken until October this year, or for nearly two years after the passage of the act relating to such receptacles.

The board now investigates and records facts concerning each case of scarlet fever, typhoid fever and diphtheria. The necessity of instituting proper measures of sanitation in that part of the city in which typhoid fever has been of most frequent occurrence was urged by the State Inspector of Health, and the matter is now under advisement by the board.

Acting upon the suggestion of the State Inspector of Health the board has appointed a bacteriologist who will examine free of charge bacteriological specimens from cases of diphtheria, typhoid fever and tuberculosis.

At the request of the board the State Inspector of Health advised as to the appointment of an inspector and a collector of milk. These officials have now been appointed, and suitable regulations for their guidance have been drawn up.

North Andover. — Advice concerning the attitude of the North Andover board of health toward certain of the communicable diseases was given on several occasions, and conferences held with the full board and its officers. The State Inspector of Health suggested that the board recodify their regulations concerning "Contagious Diseases." The board acted upon the inspector's suggestion, and requested his assistance in formulating some health regulations, which were subsequently adopted.

Salisbury. — The Salisbury board of health acted upon suggestions made by the State Inspector of Health relative to the construction of privies, the location of stables and the disposal of garbage at Salisbury Beach, by formulating, publishing, and to a degree enforcing, regulations governing the sanitation of the beach. Receptacles for rubbish were placed at convenient intervals along the beach by a committee organized for the purpose, as a result of conferences between the State Inspector of Health and the Business Men's Association.

The urgent need of a sewerage system and a proper water supply at the beach was pointed out to the local municipal authorities.

Assistance rendered the board as to the sanitation of ice-cream establishments, the location of stables and the extension of the outlet of the main beach sewer to a point below low-water mark, resulted in remedying certain objectionable conditions.

West Newbury and Rowley. — Conferences were held with the boards of health of West Newbury and Rowley, and advice given concerning the attitude of the boards toward certain of the diseases dangerous to the public health.

Factory and Industrial Hygiene.

Lighting. — The factories visited were, as a rule, well lighted. In some of the shoe factories gas was found to be replaced by electricity. Some of the rooms in textile establishments are so wide that it is impossible at all times to secure proper natural lighting in the middle aisles, but this deficiency is made good by the use of prismatic glass or by artificial lighting.

A machine shop where 800 persons were employed was inadequately lighted, largely because of dirty windows and dingy interiors. At the request of the State Inspector of Health 2,500 windows were cleaned and 350,000 square feet of interior surface whitened. The improvement in the light in this establishment was most marked; workmen employed at processes requiring attention to detail appreciated the change and performed their work better and more easily. Work in certain parts of the establishment formerly requiring the use of electric light is now done by daylight.

In a one-story building of a plant which was very poorly lighted, one-half of the roof was removed and a glass roof substituted. The management already recognizes the economic advantages of the change. Every room in this establishment is now well lighted, a much smaller number of electric lights are necessary, the employees are able to do better work, and the general appearance of the buildings is materially improved.

Cleanliness. — Cleanliness was improved in 12 small factories, at the suggestion of the State Inspector of Health.

Protection of Employees against Dust from Emery or Buffing Wheels. — In an establishment where large brass lamps for automobiles were polished on rag wheels, with the consequent production of much dust, consisting of fine particles of brass, emery and lint, the process demanded free access to all but the most distant parts of the wheel, and the problem of providing a hood which under conditions necessitated by the work will effectually remove the greater part of the dust is as yet unsolved. The seriousness of the problem was shown by the occurrence of an accident by an employee's crushing his arm between a lamp and a revolving buffing wheel and the hood attached to the machine.

In a silver factory where the emery wheels had not been equipped with hoods and blowers, a proper dust-removing apparatus was secured by blowing all discharges from the main suction pipe over a series of wooden trays kept filled with water. The silver discharged into the trays was caught by

the sheet of water and gravitated into the bottom of the tray. The trays were cleaned out at certain intervals and the silver reclaimed.

In an establishment where grinding on emery wheels was done, it was found that while the emery wheels were equipped with hoods and blowers, the suction fan was of insufficient capacity to remove the dust. Efficient changes were made, at the request of the State Inspector of Health, by equipping the battery of emery wheels with new suction pipes of proper diameters and installing a new fan approximately twice the size of the old one.

An establishment where thread and twine from flax and jute were manufactured was found to maintain an excessively dusty card room. The raw material prepared by the cards was very dusty, and the heavy machines, running at a high rate of speed, with the consequent agitation of all parts of the machine, gave rise to quantities of fine dust which remained suspended in the air. To inclose each machine appeared to be impracticable, for in the event of the ignition of the highly inflammable flax the interior of each card must be immediately accessible. It was found by experiment, however, that the greater part of the dust generated by each machine could be removed by suction from under the base of the machine. The costly apparatus now installed greatly improves the conditions for the employees. The space under the base of each card is tightly inclosed, and a corresponding area of the floor under this space is cut away to allow for the introduction of a galvanized iron hopper. The cards are arranged in series, and the pipe terminating the apex of each hopper is connected with a main exhaust pipe running beneath the cards and under the floor. This exhaust pipe is carried through the foundation walls of the card room and underground into a specially constructed dust house, which is set apart from the other buildings. The dust house is made of matched boards sheathed inside with galvanized iron plates, each plate being soldered on all sides to the neighboring plates. High up in the end wall of the building, and at a point directly opposite to the point of entrance of the entering exhaust pipe, is placed an 8-foot exhaust fan operated by an electric motor. This fan exhausts the air from the dust house, and the negative pressure is continued on through the main exhaust pipe and into the hoppers under the cards, the dust from which is directed into the hoppers by atmospheric pressure. On entering the dust house the dust settles by gravity. The exhaust fan is protected on its inner side by a metallic screen of fine mesh which serves to collect any dust which might rise to the fan level.

In a textile mill, an excessive amount of dust was found in the gassing room. The process of gassing consists of the removal of all loose fibers from cotton thread, and is accomplished by passing the thread rapidly through gas flames. In addition to the irritating gases the process is accompanied by the production of an excessive amount of dust and soot, and charred fibers so light that they remain for some time suspended in the air above the machines. The employees leave the room from time to time for fresh air. Acting upon a suggestion of the State Inspector of Health an attempt was made

to provide for efficient ventilation and removal of dust. A fan, double the capacity (9 feet) of the old one, was installed, and longitudinal apertures cut in the exhaust fans above the frames. This apparatus to an extent diminished the amount of suspended soot in the room, but did not materially improve the conditions. A new type of gassing frame, which is movable, now being used experimentally, is provided with hoods suspended over the frames and connected with the present blowing apparatus, and is proving so successful that the older frames will probably soon be replaced by the new machines. The objection to the use of hoods on the old frames was that a current of air near enough to the frame to influence the direction of the gas flames impaired the efficiency of the process.

In an establishment where celluloid combs were manufactured fumes of glacial acetic acid, used in the process of comb polishing, gave rise to considerable discomfort to one unaccustomed to them, and at the suggestion of the State Inspector of Health a suitable hood and exhaust apparatus was installed for the protection of the employees.

In an establishment where large iron parts of textile machines were ground on emery wheels, considerable improvement in the efficiency of the dust-removing apparatus was secured, at the suggestion of the State Inspector of Health, through the readjustment of the suction pipes.

Orders issued to several establishments to provide efficient hoods and blowers for emery wheels are now in process of compliance.

Water-closets. — Twenty-three new water-closets were installed in manufacturing establishments throughout the district, at the request of the State Inspector of Health. In 1 factory such changes were made in the woodwork and plumbing of the water-closets located in the center of the rooms that all of the closets are now well ventilated.

Drinking Water Supply. — In a textile establishment where 6,000 persons were employed, the State Inspector of Health suggested that the kegs throughout the mills into which ice and water were placed together, be substituted for some form of receptacle for keeping the ice and water separate. The suggestion was acted upon, and such receptacles placed in all departments of the establishment.

In another large textile factory it was found that the drinking water supplied in the summer season came immediately from wooden tanks or boxes suspended from the ceilings, one in each room; that the tanks contained ice in the water and that they were not easily accessible for cleaning. Acting upon the request of the State Inspector of Health that fresh and pure drinking water be supplied for the employees in this mill, an artesian well was sunk to a depth of 508 feet, and the water conveyed to all parts of the mill through galvanized iron pipes, insulated against the heat of the rooms through which they passed. The use of ice in summer was thus made unnecessary.

Seats for Women Employees. — Seats for women employees previously ordered in 2 establishments were found to be provided.

Receptacles for Expectoration. — Orders were issued requiring receptacles

for expectoration in a number of establishments. In instances where the local board of health had failed to make specific requirements in accordance with the statute, and no receptacles were provided, notice to this effect was sent to the board of health.

First-aid Outfits. — At the request of the State Inspector of Health first-aid outfits were provided in 15 establishments. These outfits have been found useful in many instances.

Numerical Data.

Visits to manufacturing establishments, 250.

Orders issued to provide for —	Number of Orders.	Orders complied with.	Subsequent Visit not made.
Proper water-closets,	26	20	6
Separate closets for sexes,	7	5	2
Ventilation of factories,	5	5	-
First-aid outfits,	18	11	7
Receptacles for spitting,	31	22	9
Cleanliness in factories,	12	10	2
Hoods and blowers for emery wheels and buffing wheels.	11	3	7[1]
Blowing apparatus for dust-producing machines,	2	2	-
Proper lighting,	1	1	-
Pure drinking water,	3	3	-
	116	82	33

[1] One firm to remove from the State.

Health of Minors in Factories.

Of the 1,625 minors seen and questioned, 42 were examined physically, 16 of whom were found in ill health. Two of the minors were found ill with chlorosis, 2 with anemia and enlarged tonsils, and 11 with pulmonary tuberculosis. One minor was in distinctly poor health and showed signs suggesting tuberculosis.

In every instance the minor's parents or guardians were notified. While the law provides for calling to the attention of parents of employees the ill health or physical unfitness of minors, there is no legal provision by which minors found ill with such a disease as tuberculosis may be required to submit to proper care, both for their own welfare and for the protection of other minors. Through the efforts of the State Inspector of Health, however, 8 of the 11 minors found ill with tuberculosis were placed under treatment at the day camp of the Lawrence Anti-Tuberculosis League. One minor changed his occupation to outdoor work, his regimen being directed by the Lawrence Anti-Tuberculosis League. In the first two weeks that elapsed following the change of occupation the boy gained 7 pounds in

weight. The parents of 2 minors objected to the minors' discontinuing work, on the ground of loss of pay.

A statement relative to the occupation of the 11 minors found ill with tuberculosis is interesting, but throws little light on the influence of occupation upon health, since but 1 minor has been doing the same kind of work for as long a period as two years, 4 minors for the length of time of one year, and the others varying from a period of eight months to one month. On the other hand, 9 of the minors afflicted lived in homes amid conditions distinctly inferior to those in the textile mills where the minors worked. Eight of the minors were employed in the spinning department of a large worsted mill, 3 of whom were "doffers," each for a period of one year. The work of the boy who had been in this department for two years was known as "spooling" and "weigh" boy. The other three minors in the spinning department were employed as "filling and roving tenders."

The cases of chlorosis and anemia were referred to family physicians for treatment.

In addition to the many outside influences to be considered in connection with the study of the health of minors in manufacturing establishments, one important indoor factor not now sufficiently considered is the possible untoward influence of the health of certain adults surrounding minors in their places of employment. An examination of the records of the Lawrence board of health shows few cases of tuberculosis among mill employees reported under the age of twenty-one years. Adult employees may continue at work in the mill until positive ill health causes them to seek medical advice. In the mean time they may have been the foci of infection for young persons about them. The average adult employee of a textile mill is closely confined at his work. In the two major departments of the textile industry, weaving and spinning, where men, women and minors are employed, little opportunity is given for the adult employee to move far from the machine which he operates, while, on the other hand, the minors who perform unskilled work are not confined to any one locality, but are brought into contact with each other and with many adults, some of whom undoubtedly have tuberculosis or other infectious disease which, because of neglect of proper precautionary measures, may readily be transmitted. The average minor, therefore, through his wide range of activity in employment and closer contact with other employees, exposes himself more to infection from tuberculosis or some other communicable disease than a given adult in the same department.

Schoolhouse Hygiene.

Twelve schoolhouses were inspected during the year and detailed reports of the conditions found were filed in the office of the State Board of Health.

In only 1 schoolhouse was the ventilation adequate; in all the others the ventilation of the classrooms was inadequate. In 1 schoolhouse it appeared to the State Inspector of Health that with a reasonable outlay of expense an adequate ventilating system might be installed. The inadequate ventilation

was rendered still worse in 6 of the schoolhouses by distinct overcrowding of many of the classrooms.

The toilet facilities were unsatisfactory in 5 of the school buildings. The toilets were either improperly located, poorly ventilated or unsanitary. Two of the schoolhouses were in such condition that in the opinion of the State Inspector of Health they were totally unfit for school purposes, and to render them suitable for such use the expenditure would be out of proportion to the cost of new buildings.

To the authorities of 1 private school an order was issued to provide proper water-closets. The order was complied with.

Orders relative to adequate ventilation and proper water-closets in 3 schoolhouses in Haverhill were issued to the municipal council of said city. The orders were satisfactorily complied with.

As a result of facts disclosed by the State Inspector of Health relative to the inadequate ventilating provisions of the grammar school at West Newbury, the authorities discarded the building for school purposes and constructed a new schoolhouse.

The lighting of the schoolhouses was in general fairly satisfactory. In only 1 school building 6 of the classrooms were poorly lighted. In several instances light entered from rear and right instead of left. These conditions could be remedied by a readjustment of the seats.

The cleanliness of all the schoolhouses visited was in general found to be satisfactory.

Slaughtering and Meat Inspection.

During March the State Inspector of Health investigated the 29 slaughterhouses within his district, and classified them from a sanitary point of view as follows: —

Worthy of especial commendation,	4
Satisfactory,	7
Moderately bad,	6
Distinctly bad,	12

These slaughterhouses were divided among 12 cities and towns, 3 towns having no slaughterhouse. One hundred visits were made to the establishments in the endeavor to bring all of them up to a satisfactory standard, and in October the same slaughterhouses were rated as follows: —

Worthy of especial commendation,	5
Satisfactory,	21
Moderately bad,	–
Distinctly bad,	–
Out of business,	3

It will be noted that the number of slaughterhouses found in satisfactory condition increased from 25 per cent to 73 per cent.

In addition to examining the slaughtering establishments, 56 visits were made to those retail stores in Lawrence which were receiving meats from the local or nearby slaughterhouses, and a number of seizures of unstamped meats made. Later on, careful inspections of the meats in these stores failed to show any violation of the statute relating to the sale of unstamped meats.

On March 18, 1909, the following conditions existed with regard to the local inspection of meats. In only 2 cities and 3 towns of the 12 cities and towns in which slaughtering establishments were maintained were carcasses subject to an inspection by a local inspector of meats. One city had an inspector, but there was no inspection. One town in which there was but 1 slaughterhouse had appointed no inspector, as the establishment was subject to United States inspection. Five towns in which slaughterhouses were located were without inspector and inspection.

As a result of his investigation the State Inspector of Health made the following recommendations to boards of health: —

To the Andover Board of Health. — That the board require all slaughterhouses in town to be licensed, that a definite standard for licensing be adopted, that slaughtering be allowed only on certain days, and that an inspector of meats and provisions be appointed. These recommendations were adopted by the board.

To the Lawrence Board of Health. — That the board appoint an inspector of meats and provisions, that certain slaughterhouses be placed in proper condition before licenses for slaughtering are granted to the proprietors thereof, that slaughtering be permitted only on certain days, and that the proprietor of 1 establishment be refused a license. The proprietor of the establishment referred to did not renew his application for a license. The other recommendations met with the favorable action of the board.

To the Board of Health of Methuen. — That the board appoint an inspector of meats and provisions, that slaughtering be allowed only on certain days, that the board issue no licenses to proprietors whose establishments are not in proper sanitary condition, and that the proprietors of 2 establishments be refused licenses. These recommendations were severally complied with, although after a lapse of three months the proprietors of 2 establishments who were refused licenses were allowed to resume business. One of these establishments had been placed in proper sanitary condition, but the other was permitted to remain in a condition unfit for slaughtering.

To the Board of Health of Newbury. — That the board require the inspection of all carcasses in slaughterhouses, and that slaughtering be permitted only on certain days. These recommendations received the favorable action of the board.

To the Board of Health of Boxford. — That the board appoint an inspector of meats and provisions. Such an official was appointed.

To the Board of Health of Salisbury. — That the board appoint an inspector of meats and provisions. This recommendation was complied with.

Health District No. 9.

Charles E. Simpson, M.D., *Lowell, State Inspector of Health.*

This district includes the cities of Lowell and Woburn, and the towns of Acton, Arlington, Ayer, Bedford, Billerica, Boxborough, Burlington, Carlisle, Chelmsford, Concord, Dracut, Dunstable, Groton, Harvard, Lexington, Lincoln, Littleton, Maynard, Pepperell, Shirley, Stow, Tewksbury, Townsend, Tyngsborough, Westford, Wilmington and Winchester.

Diseases Dangerous to the Public Health. — Communicable Diseases.

Following are the records of steps taken by the State Inspector of Health in the prevention of the spread of communicable diseases in various localities: —

November 19. — On learning of a person who was ill with diphtheria in one town, and that this person had been working among several others in a neighboring community, the State Inspector of Health notified the authorities of the latter town to take certain precautions.

November 21. — An outbreak of chicken pox was investigated in Townsend. Eleven school children attending the same school and in the same room became ill with the disease within a few days of each other.

January 7. — The Haverhill board of health was notified of a person found in Lowell ill with pulmonary tuberculosis who worked in a candy store in Haverhill.

January 16. — A man in Woburn, seriously ill with tuberculosis, was visited. He had a family of children and produced milk for public sale, but the patient was properly cared for and the public safety guarded.

January 28. — An outbreak of scarlet fever in Arlington was investigated, and was thought to be due, in part, to the failure to recognize the disease.

March 13. — Two cases of scarlet fever in Winchester were investigated, and it was found that neither had been treated by a physician, and that both were unreported to the local board of health.

May 20. — Advice was given to the board of health of Stow relative to a person ill with typhoid fever.

June 19. — Advice was given to the Harvard board of health relative to a person in ill health who was a chronic spitter.

July 21. — The Maynard authorities were assisted in the diagnosis of a person ill with disease, which proved to be scarlet fever.

July 29. — Investigated a well in Stow the water in which was so polluted that it was considered a possible cause of the death of two persons in one family from a virulent type of typhoid fever.

August 12. — An investigation of several cases of typhoid fever at Willardale, a summer resort in Tyngsborough, and Dracut, disclosed the fact that the sewage disposal in the whole community was objectionable. Two of the persons ill with typhoid fever had been drinking water from wells

within 30 feet of each other and within about the same distance from two privies located on higher ground. Cesspools were found in the same basin as the wells. There was much fishing and bathing in the lake, around which there were many cottages. Two hotels were taking all of their drinking water from the lake. There was a public park near the same body of water. Driven well water was supplied for drinking purposes, although lake water was used for kitchen purposes.

September 25. — A few cases of typhoid fever in Maynard were investigated. During the last four years several cases of this disease occurred among people who took milk from one dealer who had the disease himself four years ago. Although most of the houses occupied by the patients were connected with the town water supply, some of the patients had been accustomed to drink water from a well near which were several cesspools.

During the investigation of a case of typhoid fever in Lexington, analysis of a supply of well water showed the water to be much polluted, and the use of the well was discontinued.

October 4. — It was learned that there had been 2 cases of diphtheria with 1 death in Townsend, and the local board of health was consulted relative to the management of quarantine of persons ill with this disease. Four days later the chairman of the board asked for a conference, but at the time appointed the State Inspector of Health found a public meeting in session, and during the course of the meeting gave an extemporaneous talk on diphtheria and its management, covering the duties of the family, the physician, the health authorities and the public. Up to this date there had been three patients and two deaths; in one instance the doctor was called late and the person died from post diphtheritic nephritis; in the other instance the patient was not given antitoxin. After the meeting three suspicious cases were seen with their physicians, and all judged to be ill with diphtheria, as was later shown by cultures. At the request of the chairman of the board of health, the State Inspector of Health submitted detailed written suggestions to the board and no further cases were reported. While the cause of the outbreak was not definitely determined, it was learned that all the children were in two rooms of a school building, and that one of the cases was the mother of a child who died. It was also learned that the town in which the afflicted ones did most of their trading was having an outbreak of diphtheria, and that up to a week or two before the outbreak in question that town had not considered membranous croup a form of diphtheria, and had taken no quarantine precautions in such cases.

October 8. — Advice was given the Maynard authorities relative to the necessity for quarantine measures in a suspicious case of typhoid fever, which later proved to be measles.

Local Nuisances.

Nov. 10, 1908. — A manure pile on Magnolia Street, Arlington, 300 feet long, within 100 feet of the street, and less than 200 feet of houses, was found to constitute a nuisance, and so reported to the local board of health. A person in a house near by died of typhoid fever.

May 17, 1909. — Filthy toilet conveniences in a building in Arlington were found to be used by four families. Sewage was overflowing from an inadequate cesspool on adjoining land. These conditions were called to the attention of the local board of health and satisfactory orders were issued for their improvement.

July 7, 1909. — Owing to a faulty location of a cesspool on River Street, Maynard, it was found that considerable sewage flowed at times on the neighbors' land, and that because of a leaky pipe connected with the same cesspool two cellars were flooded.

Sept. 17, 1909. — Investigation of the conditions on River Street, Maynard, disclosed the fact that the leaky drain had been repaired, so that the cellars were dry, although the location of the cesspool remained unchanged. The State Inspector of Health made suggestions which, if followed, would relieve matters for some time to come and permanently improve the property.

Sept. 30, 1909. — A piggery and other nuisances in Burlington were investigated, and the attention of the local board of health called to the same for consideration.

Factory Hygiene.

Fifty-three visits were made to 35 factories representing 30 different industries. Eighteen of the visits were for re-inspection purposes. The orders given for changes in 27 factories were as follows: —

Proper water-closets,	5
Greater cleanliness,	5
Removal of acid fumes,	1
Avoidance of excessive steaming,	1
Protection against dust from emery wheels,	2
Whitewashing,	1

Notices issued relative to violations of the law as to provisions for: —

Medical and surgical appliances,	13
Receptacles for expectoration,	14

So far as could be determined before the end of the year the following orders were complied with: —

Provisions made for proper water-closets in 5 factories and for greater cleanliness in 3. The orders relative to the removal of acid fumes, the avoid-

ance of excessive steaming, the protection against emery dust, and whitewashing were all complied with. Receptacles for expectoration were provided in 3 factories, and medical and surgical appliances in 1 factory.

Health of Minors in Factories.

Two thousand eight hundred and six minors were seen and questioned.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	60	103	146	171	250	213	173	1,116
Female,	71	143	215	254	347	326	334	1,690
Total,	131	246	361	425	597	539	507	2,806

The following table shows the number of minors found in ill health or with some physical unfitness: —

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	1	2	1	4	4	2	1	15
Female,	4	1	6	7	11	7	5	41
Total,	5	3	7	11	15	9	6	56

Forty-six minors, 30 girls and 16 boys, were found to have a family history of tuberculosis.

List of Physical Defects found in Males.

Anterior synechia,	1
Blepharitis,	1
Conjunctivitis,	4
Hypertrophied tonsils,	1
Lachrymal abscess,	1
Leucoma,	2
Strabismus,	1
Torticollis,	1
Total,	12

List of Physical Defects found in Females.

Adenoids,	1
Alopecia,	2
Amenorrhœa, anæmic,	1
Anæmia,	6
Atrophic rhinitis,	2
Blepharitis,	1
Bronchitis, chronic,	1
Cleft palate,	1
Conjunctivitis,	6
Deaf and dumb,	1
Dermatitis, tubercular,	1
Enlarged glands,	3
Hordeolum,	1
Hypertrophied tonsils and cerumen,	5
Laryngitis,	1
Leucoma,	2
Otitis media,	2
Phthisis bulbi,	1
Strabismus,	4
Torticollis,	2
Total,	44

The above cases of anæmia were tested and found to have from 65 per cent. to 90 per cent. hæmoglobin.

Industrial Hygiene.

Cleansing and Dyeing. — The use of naphtha and benzine in cleansing is attended by two dangers, — (1) the danger from inhalation, which may give rise first to a feeling of exhilaration, then of stupor, and, if its use is long continued, to a tendency to strangury and (2) danger of fire. In the establishment visited benzine cleansing was carried on in a small, cheaply constructed shed, built on the edge of a canal into which men were instructed to jump at the first appearance of fire. The shed consisted of 2 rooms in which but 2 men were found at work. The rooms were ventilated with comparatively large windows.

Manufacture of Celluloid Combs. — A new establishment in which celluloid combs were manufactured, the only one of its kind in the district, was discovered, and it was found that several polishing wheels were without blowers to protect workmen against dust, and that although acid dipping was conducted in a separate room under a hood, the draft was not sufficient to take away the fumes.

Manufacture of Cordage. — The same conditions were found present as in cotton mills using very coarse, cheap grades of cotton.

Manufacture of Electrical Apparatus. — Aside from the shocks and burns to which employees were subjected in "testing" were found the usual dangers which arise from the processes of polishing and burnishing, as well as the irritating effects from plating and lacquering.

Furniture Repair Shop. — In a large establishment where furniture was repaired and mattresses and cushions renovated, the department where women were sewing contained in a corner a picker, which was used to loosen and dust cotton and hair from old mattresses and cushions. Although the machine was partly cut off from the rest of the room and ventilated into a chimney, there was not sufficient draft to remove all the dust, and the women were exposed not only to the irritating vegetable dust but to dust which may have contained infected matter.

Manufacture of Leather Heels. — In an establishment where leather heels were manufactured an employee was found ill with tuberculosis in an advanced stage, and it was observed that men habitually expectorated among the piles of waste chips of leather. It was found to be the custom, after such chips remained for some time in the establishment, to gather them up and sell them. The chips must then be handled by men for the purpose of making leather board or other by-products. Such a condition of affairs is by no means peculiar to the leather heel industry, but is applicable to many establishments where waste products and floor sweepings are saved for future use.

Printing Establishments. — It was found that the dangers in printing establishments were confined to conditions which might give rise to lead poisoning and to irritation from "bronze powder." While the danger from lead poisoning appears to be much diminished by the linotype machines, by means of which a whole line is blocked off instead of a single letter, much work is done by setting up individual letters, and many men were found who admitted that in this process they frequently held the type in the mouth. No case of lead poisoning was discovered, but a boy in one of the establishments stated that his father, who had worked in a similar establishment, contracted lead poisoning and died. Most of the job printing establishments and many of the paper box workshops used "bronze" in dry powder which was dusted over adhesive material. In this process the powder gets into the air and many workmen complain of its irritating properties.

Stone Cutting. — In the establishments visited where machinery was used there was much dust in the air of the rooms to which the workmen were exposed.

Chrome Works. — The only factory of the kind has been closed, so that the effects of chrome dust on the health of employees may no longer be studied. So-called "chrome sores," however, have been found in print works, where men are accustomed to put their hands in coloring solutions containing chrome.

Tanneries. — In handling limed skins and taking the hair from them, employees get short pieces of the hair under their finger nails, which not

infrequently give rise to infection, — a condition which may be, and sometimes is, mistaken for felons and treated for such, whereas, if understood, it can be treated with much less inconvenience to the patient.

Rendering Works. — The rendering works in Billerica have been much improved by the completion of a water tower, to which runs a large fan shaft connecting with hoods placed over the most offensive processes.

Schoolhouse Hygiene.

At the request of the school committee in Bedford a schoolhouse was examined. Owing to a large hole burned through the vault of each furnace, so that the fire box connected directly with the hot-air flues, gas and smoke escaped through the latter. While the holes were temporarily repaired with a mixture of lime and cement, it seemed to the State Inspector of Health that the iron would soon burn through, and that the other substance would crack.

In Lowell 13 schoolhouses were examined. In 5 buildings the ventilation was bad in the whole or a part of the building; and in 5 instances lighting could be improved without unreasonable expense. In 2 buildings a foul odor escaped from the water-closets. Three closets were found which might easily be connected with the sewer.

In each of the 4 buildings where furnace heat was used there was evidence of smoke in the air pipes, and in 1 school the teacher complained that so much coal gas gave rise to headaches.

In 2 buildings there was evidence of overcrowding in some of the rooms. One of the buildings, however, will be relieved by the opening of a new schoolhouse in the district.

In Chelmsford a school which occupied 3 buildings was examined. Two of the buildings were slightly overcrowded. In 1 the heating and ventilation were poor, and in 1 due regard was not given to the arrangement of seats to obtain the best light. Scholars in 1 building were obliged to use water-closets in another.

At the time of the inspection the school committee were unable to decide whether to enlarge the present building or to erect a new one in another part of the village.

Tenement Hygiene.

Sixty-seven tenement houses were visited and 66 licenses granted. One license was refused. Two licenses were revoked on account of diphtheria and scarlet fever, and the employer who hired the work done was notified to this effect. When the licenses were renewed the employer was likewise notified. Ten houses were examined for transfer of licenses.

Slaughterhouse Inspection.

Since the summary of the slaughterhouse conditions in this district was made, 5 additional establishments were licensed for slaughtering, thus bringing

the number of licensed slaughterhouses up to 54. The town of Chelmsford finally appointed five meat inspectors, one of whom was to supervise the work of the others. Two of the inspectors appointed were men hired by butchers. They were to serve without pay. Two other inspectors were sons of butchers, one of whom was to serve without pay, and one was a selectman who, himself, was a licensed butcher.

Public Buildings.

The G. A. R. Hall in West Acton was found to be without water-closet accommodations. The owner of the building promised to install conveniences especially for the use of the G. A. R. members and the public, or to permit the use of the other closets in the building.

Health District No. 10.

Wm. W. Walcott, M.D., *Natick, State Inspector of Health.*

This district includes the cities of Marlborough, Newton and Waltham, and the towns of Ashland, Belmont, Brookline, Dover, Framingham, Grafton, Holliston, Hopedale, Hopkinton, Hudson, Medfield, Medway, Mendon, Milford, Millis, Natick, Needham, Northborough, Sherborn, Shrewsbury, Southborough, Sudbury, Upton, Watertown, Wayland, Wellesley, Westborough and Weston.

Diseases Dangerous to the Public Health.

Assistance was rendered to the State Inspector of Health of District No. 2 in his investigation of an outbreak of typhoid fever in Fall River. Small outbreaks of scarlet fever occurred during the year in Newton, Brookline and Waltham.

Local Nuisances.

Numerous complaints were received of the existence of alleged local nuisances, all of which were investigated. In no instance was there any basis found for the complaint. Between 1907 and 1909 about 90 such complaints were investigated, and only in 1 case was the investigation worth while. Most of the complaints were apparently due to personal feeling on the part of the complainant. A few illustrations may show the nature of the complaints: — It was alleged that the sewage from an institution located at Grafton was seriously polluting a certain brook: investigation showed a series of model filter beds, making pollution of the brook impossible. A man complained of disagreeable odors coming from a near-by barn: at the time of the visit everything was entirely satisfactory. Finally, the complainant stated that the location of the barn interfered with the sale of his property and he hoped the State Board of Health would cause the barn to be removed. The water-closets of a certain hotel were said to be filthy: they were found in good condition. A certain piggery was said to be a menace to the public health: investigation showed a well-kept pig-pen containing two small piggeries.

Factory and Occupational Hygiene.

One hundred and forty-five factories, including 44 different industries, were inspected, and each industrial process was studied in detail, from the raw material to the finished product, with special reference to any processes which might be dangerous to the health of those employed in them. The investigation is not yet completed, and the publication of the results will, therefore, be postponed until the next annual report.

In 12 establishments violations of the law were found, and orders requesting changes were issued as follows: —

To improve conditions of water-closets,	5
To increase the efficiency of dust removal,	5
To provide washroom in a foundry,	1
To improve ventilation,	1

All these orders have been complied with.

Health of Minors in Factories.

No minors were found employed under dangerous or unfavorable conditions as to health.

Tenement Hygiene.

Eight licenses to work on wearing apparel in tenements were issued.

Schoolhouse Hygiene.

During the month of June, 11 schoolhouses were inspected. In 3 large brick school buildings a ventilating system was in use which proved entirely satisfactory. Each room was provided with adequate entrance and exit flues, the larger rooms having two of each. The main ventilating shaft was provided with steam coils, to insure the circulation of the air. The fresh-air chamber was supplied with air by means of a twin 9-foot fan, which forced from between 90,000 and 100,000 cubic feet of air per minute into the main entering shaft, to be distributed into the various class rooms. The average air space per capita in these buildings was 433 cubic feet. In 3 other school buildings each room was found provided with an inlet for fresh air near the top, and an outlet near the floor. The inlets were connected with the fresh-air chamber in the basement; the outlets were connected with large ventilating shafts provided with steam coils, to facilitate the circulation of the air. These coils were heated by means of a small boiler, which was used only during the warm weather, when the building was not heated. One large country school building was ventilated by means of window boards. On account of the small number of pupils the air space per capita was 600 cubic feet and the ventilation was adequate. One small, two-room school building, containing 60 pupils, also had window ventilation, which was found adequate.

The light in the schoolhouses was, as a rule, found to be satisfactory, and

was generally from the left and rear of the pupils. The water-closets were satisfactory in all the schoolhouses visited, with the exception of 1 country school building, where they were particularly offensive. All the buildings, without exception, were surrounded by plenty of air space and playgrounds, and neither light nor air was cut off by adjacent buildings.

Health District No. 11.

Melvin G. Overlock, M.D., *Worcester, State Inspector of Health.*

This district includes the city of Worcester, and the towns of Auburn, Brookfield, Charlton, Douglas, Dudley, Leicester, Millbury, Northbridge, North Brookfield, Oxford, Southbridge, Spencer, Sturbridge, Sutton, Uxbridge, Warren, Webster and West Brookfield.

During the year visits were made to every town in the district. Six hundred and thirty-four official visits were made to factories, tenement houses, mercantile establishments, schoolhouses, slaughterhouses, public buildings, hotels and restaurants, as follows: —

Factories,	211
Mercantile establishments,	70
Tenement houses,	23
Public buildings (including schoolhouses),	57
Slaughterhouses,	245
Hotels,	7
Restaurants,	8

Diseases Dangerous to the Public Health.

The State Inspector of Health reported that more than one-half of the towns failed to report cases of tuberculosis, and that the physicians in the two largest towns reported comparatively few cases.

The State Inspector of Health has secured the co-operation of some employers, in the prevention of the spread of tuberculosis, by obtaining their consent to offer to pay a portion, or all, of the expenses of any regular employee found to have tuberculosis, who can obtain admission to the State Sanatorium at Rutland for varying periods — generally for three months — or until cured. A detailed statement of what has been done along this line will be given in a subsequent report.

Nine cases of typhoid fever in the town of Oxford were investigated, and while the cause of the spread of the disease could not be determined, it was observed that the privies were generally in an unsanitary condition and were exposed to flies in large numbers. None of the houses were screened. The owners of the buildings were instructed to clean the privies and to disinfect with chlorinated lime. After these precautions were taken the disease ceased to spread. In Southbridge 5 cases of typhoid fever were investigated. In 1 instance the patient had been drinking water from a badly polluted well. The first patient of the remaining 4 cases was in a house where no care was taken of the stools or urine, both of which were deposited in a privy about 20 feet from the kitchen windows.

Factory Hygiene.

A new system of ventilation was installed in 9 factories and workrooms. In 7 instances manufacturers were requested to maintain a higher degree of cleanliness in their factories. One firm was requested to provide better light and 1 firm was required to provide proper water-closets. Receptacles for expectoration were required in 16 factories. Seats for women employees were required and provided in 1 mercantile establishment.

Health of Minors in Factories.

Two thousand, two hundred and forty-three minors were seen and questioned, 93 of whom were examined physically. In 31 instances advice was given to the minor's parents as to the health of the minor.

Schoolhouse Hygiene.

During the year 42 schoolhouses were inspected. In most of the buildings conditions as to ventilation, lighting and toilet facilities were found to be satisfactory. In several school buildings the ventilation was found inadequate in some of the rooms, and in others the lighting was poor, either on account of lack of window space or because of the unwhitened condition of the ceilings and walls.

The Providence Street School in Worcester was, in the opinion of the State Inspector of Health, entirely unsuitable for school purposes. It had an inadequate heating system, the temperature in some of the rooms ranging between 53° to 85° F. The ventilation was inadequate, and the water-closets were not sufficiently flushed. Conditions which in the case of fire would be a menace to the safety of pupils were also found in this building.

The Ash Street School in Worcester was found to consist of an old wooden building containing one small class room attended by 29 children. It was poorly ventilated, poorly lighted and not kept clean, and, in the opinion of the State Inspector of Health, was unfit for school purposes.

In the Webster Square School building in Worcester both light and ventilation were found inadequate. The chamber supplying fresh air to the building was within 20 feet of a stable where 18 or 20 horses were kept during the winter and spring. The water-closets in this building were likewise in an unsanitary condition.

The old Woodland Street School building, which was inspected last year, where unsatisfactory conditions were found, was reinspected. No improvements had been made. It was inadequately ventilated and the water-closets were so old that they could not be kept in a sanitary condition.

The Thomas Street School in Worcester was visited by the State Inspector of Health last year, and the objectionable conditions found were called to the attention of the school committee. Nothing, however, has this year been done to remedy the conditions. The air supplied to the schoolrooms comes from the back of an uncleanly kept stable. The ventilation of both the class rooms and toilets is inadequate. The light is poor, the water-closets are

unsanitary, and in the kindergarten class both boys and girls use the same toilets. The roof of the building is leaking, and many of the rooms and basement are damp. The floors are in a poor condition and cannot be kept clean. This building, in the opinion of the State Inspector of Health, is unfit for school purposes.

The Canterbury Street Schoolhouse was inspected last year and certain changes were recommended to the school committee. At the present visit it was found that the building was undergoing extensive alterations. An entirely new system of water-closets was being installed, and provisions made for more adequate ventilation.

In the Belmont Street School building one of the rooms which was found last year unsuitable for school purposes had been opened.

The use of water by pupils in a schoolhouse in Auburn was discontinued, since the water was examined and found to be badly polluted.

Slaughterhouse Inspection.

Two hundred and forty-five visits were made to slaughterhouses in Worcester County, but no illegal slaughtering was discovered other than that known and acted upon by the local board of health. The State Inspector of Health requested the proprietors of slaughterhouses to maintain a higher degree of cleanliness in their establishments.

Health District No. 12.

Lewis Fish, M.D., *Fitchburg, State Inspector of Health.*

This district includes the city of Fitchburg, and the towns of Ashburnham, Ashby, Athol, Barre, Berlin, Bolton, Boylston, Clinton, Dana, Gardner, Hardwick, Holden, Hubbardston, Lancaster, Leominster, Lunenburg, New Braintree, Oakham, Paxton, Petersham, Phillipston, Princeton, Royalston, Rutland, Sterling, Templeton, Westminster, Winchendon and West Boylston.

Diseases Dangerous to the Public Health.

Gardner. — An outbreak of diphtheria, which threatened to become epidemic, occurred in this town. Frequent conferences and visits to the homes of patients, with local authority, resulted in the removal of all cases to the isolation hospital, and observance of very rigid quarantine of all exposed persons. No case was released from the hospital until a negative culture was obtained; neither were any persons released from quarantine until a negative culture was obtained from their throats. A total of 23 cases were reported.

An outbreak of typhoid fever was investigated. The cases were somewhat sporadic, and no common source of infection was found. All the farms from which milk was obtained were inspected, and although filthy conditions prevailed under which the milk was being produced, no history of illness was obtained on any of the farms.

A case of scarlet fever which occurred on a milk-producing farm was investigated with the local health authorities. The case had been properly isolated and the milk supply shut off by order of the board. Upon the advice of the State Inspector of Health the board ordered all milk utensils removed from the place of quarantine to a neighbor's, where they were thoroughly sterilized; a man was secured to attend to the farm work. He was to live at the place to which all milk utensils were removed, and have no communication with the quarantined house. These rules were closely followed until the place was released from quarantine. No other cases resulted from this one.

Hubbardston. — An outbreak of scarlet fever occurred in this town in December, 1908, which was investigated. A lax quarantine in the beginning of the outbreak was possibly responsible for several cases occurring later. A conference was held with the local health authorities, and advice and information given relative to the best means of preventing the spread of the disease.

At a later date a case of scarlet fever and one of diphtheria, occurring upon milk-producing farms, were investigated, and suggestions in each case were offered to the local health authorities as to the best means to adopt to prevent the spread of the disease. The suggestions were followed.

Lancaster. — An outbreak of scarlet fever among the students attending the academy located at South Lancaster was investigated, and close observance of quarantine established by the local health authorities was found. The outbreak was confined to the initial cases.

Advice was asked for by the local health authorities concerning quarantine of a milk-producing farm on which existed a case of scarlet fever. The board was advised (*a*) to order the removal of all milk utensils from the household and to see that they were thoroughly sterilized; (*b*) to secure a person to attend to the farm work who would have no communication with the family; (*c*) to detain in quarantine the father of the child, who had been doing the farm work.

Leominster. — An outbreak of diphtheria now exists in this town. A large number of cases have occurred among school children attending one school (North Leominster). The school building has been disinfected and cultures taken from the throats of children attending this school. Those showing up positive are reported to the board of health and quarantined. A strict quarantine of all cases is being exercised. No release culture is permitted to be taken until the tenth day from the time the case was reported; if positive, another is not allowed to be taken for six days; if negative, a culture is then taken by the physician connected with the board, and if both are negative the case is released. Should the board's culture prove positive the case is detained in quarantine another week, when the same procedure is repeated.

Sterling. — Seven cases of diphtheria occurring in one family were investigated. These cases occurred in the household of a farmer from whose place several cans of milk had been shipped daily into the Boston market. This supply was discontinued and quarantine established. Upon the advice of

the State Inspector of Health none of the cases were released until a negative culture was obtained.

Templeton. — An outbreak of diphtheria occurred in December, 1908, in Otter River, a village of this township, among children attending the same school. It was found that the 3 initial cases had been in attendance at school while feeling ill and previous to having been seen by a physician. In the course of a few days 15 cases occurred. The local health authorities had released 1 case within a week of the onset of the illness, on the report of the attending physician "that the child's throat was clean and ready to be released." Upon the advice of the State Inspector of Health the board immediately required a negative culture to be obtained before release. The enforcing of this rule necessitated repeated visits to assist the board in maintaining a strict quarantine, and in further advising them as to the best course to follow to prevent the further spread of the disease.

Winchendon. — An outbreak of scarlet fever occurring during the months of November and December, 1908, was investigated. The school at which the children ill were in attendance was closed, and all school books used by the children were burned. No other cases appeared among children attending this school. A few cases were later reported from different and widely separated sections of the town. Strict quarantine was maintained in each case.

A case of typhoid occurring in a family in which there were several other children was investigated. The mother was found to be taking care of the child and attending to her housework as well. To prevent any possible contact cases it was suggested to the board of health that a nurse be provided, and this suggestion was acted upon. No contact cases occurred.

Ashburnham. — An outbreak of diphtheria was investigated during the month of January, 1909. A strict quarantine was maintained, and upon advice of the State Inspector of Health no cases were released until a negative culture was obtained. The outbreak was confined to a few cases.

Athol. — A sporadic case of typhoid was investigated. The house was supplied with well water, the well being located in the cellar. Nine privies, used by 6 families, were located about 35 feet from the well, the drainage being in the direction of the well. Upon analysis the water showed gross pollution, and was condemned by the local health authorities. No other source of infection could be found.

Holden. — During the month of August, 1909, 7 cases of typhoid were investigated. They were found to be household cases, located in widely separated sections of the town. Five were possibly due to unsanitary conditions existing upon farm places, 1 was possibly infected while at work tearing down an old building in a neighboring village, and 1 was a contact case brought in from a neighboring city. Upon one of the places seventeen to eighteen 8½-quart cans of milk were produced and shipped daily into a neighboring city. Every precaution was exercised to prevent the spread of the disease.

An outbreak of typhoid occurring late in September, 1909, among a party of people from Boston and vicinity, who were found to have re-

mained at a local hotel, where infection probably took place, was investigated. No connection was found with these and previous local cases. Local farms from which milk was obtained were examined, but no history of illness of an infectious nature was obtained in any one of them. It was learned that upon the farms in Oakham and Barre, from which twenty 4½-gallon cans of milk were furnished to the hotel daily, no cases of typhoid had been reported to the local health authorities. The water appeared above suspicion, town water and well water being furnished. There was no source of pollution within a large area of the well, and it was provided with good surface protection. A large number of guests throughout the summer had drunk freely of the water without any resulting illness. The barns and stables were located a reasonable distance from the hotel and were reasonably clean. A faulty drain was found immediately back of the kitchen, where stood an old-fashioned refrigerator, in which were kept the milk cans. There was evidence of a lack of neatness and thorough cleanliness in taking care of and in handling milk and vegetables. An abundance of flies were present in the dining room. The sources of infection simmered down to some infected food or milk.

Anterior Poliomyelitis. — Through the courtesy of the attending physicians, 4 cases of anterior poliomyelitis were seen in Athol, Fitchburg and Leominster. Retainers were provided the attending physicians in Athol and Fitchburg. Inquiry blanks were also furnished the physicians in attendance upon the cases.

Tuberculosis. — The physicians of the district are, in general, making prompt reports of cases of tuberculosis to the local health authorities. There have been very few cases reported, however, from the towns of Athol, Hardwick and Winchendon. In each of these towns the local health authority has been urged to send out circular letters to the local physicians, calling their attention to the statute under which they are required to report notifiable diseases, and requesting that all cases of tuberculosis be reported. In the city of Fitchburg and towns of Clinton and Gardner active and efficient work is being done to cure and eradicate tuberculosis. In Fitchburg more cases are being reported than ever before. A large number of cases have been given care at the State institution at Rutland and in hospital cottages at the expense of the local health authorities. The question of providing a hospital for these cases, to be run under the direction of the local board of health, has been considered. Sites for such a hospital have been looked over, but no definite action has yet been taken. A free tuberculosis clinic has been established in connection with the local society for the control and cure of tuberculosis, and a large number of cases have been disclosed that otherwise would not have been reached.

(*a*) *Clinton.* — The day camp established here last year is providing care for patients from the neighboring small towns as well as for its own local cases. Local physicians are co-operating with the local health authority in freely and promptly reporting their cases.

(*b*) *Gardner.* — During the past year this town has been particularly active

in tuberculosis work. The Boston Tuberculosis Exhibit was brought here for one week, and was largely attended. Very recently a free tuberculosis clinic was established in connection with the local society for the control of tuberculosis. The local physicians are reporting their cases better than ever before.

Local Nuisances.

Ashburnham. — The cellar of a dwelling house in which the sink drain pipe was broken, allowing all the sink waste water to fall and collect upon the cellar floor, was inspected, and the conditions were called to the attention of the local health authority. New drain pipes were installed and made tight, resulting in the removal of the unsanitary condition. The privies connected with the place were found in poor repair and unclean. These were repaired and cleaned out.

Athol. — Privies that were undoubtedly a source of pollution to a well, the water of which was being used by 6 families and upon analysis showed gross pollution, were called to the attention of the local health authority, who, upon the suggestion of the State Inspector of Health, ordered the premises to be connected with the public sewer. The work is now under way.

Barre. — The local health authority asked for advice concerning a filthy and undrained cellar of a dwelling house, which the owner had neglected to improve upon the verbal order of the board. The State Inspector of Health suggested that the board serve upon him a written order, directing that the necessary changes be commenced within twenty-four hours of the service thereof pending the institution of court proceedings. This was done and the nuisance was abated immediately.

Fitchburg. — An alleged nuisance arising from privies upon a street not having a public sewer was investigated, and it was found that a petition, signed by nearly all the residents on the street, had been presented to the city government, asking that the sewer be extended to the street. The largest property owner on the street opposed the petition, and the petitioners were given leave to withdraw. The street is located upon the outskirts of the city, and while sewer connection would be a decided improvement to this section from an æsthetic point of view as well as for sanitary reasons, no distinct nuisance was found to exist.

An open stream of water receiving considerable sewage which passed through a cellar of one of the mercantile establishments, upon examination presented a distinct nuisance and danger to the health of the occupants of the building. Because of some error in the passage of legal papers by the city street commission to the city clerk, the removal of this condition had been delayed for nearly a year. After a conference with the health and legal departments of the city, work was commenced upon a cement covered raceway, which has completely removed the nuisance.

A shack located in a thickly settled section of the city, in which lived a person doing shoe repairing, was found to have no sanitary provisions, the excreta being disposed of into a catch basin near at hand. The matter was

called to the attention of the local health authority, who ordered the installation of sanitary provisions or closure of the place. Proper sanitary provisions were installed.

Upon complaint of a person that the privies at the West Fitchburg depot, Boston & Maine Railroad, were in a filthy condition, an examination was made and conditions found as represented. A written order, directing that the privies be cleaned out and kept clean, was issued to the agent of the road having charge of the premises. The nuisance was abated.

Gardner. — Three of the principal livery stables of the town were visited in company with the local health authorities upon complaints received by the board that the odors arising from one in particular were offensive. Changes were requested to be made in the one against which complaint had been made. The changes involved better drainage, closing in of the cellar on one side and installation of vent shafts. The changes were promptly made. There appeared no necessity for changes in the other two liveries.

A stream of water, upon whose banks are located a number of factories, the privies of which are built in most instances directly over the stream, while in two instances they are built upon its banks, was investigated with the local health authorities. The stream passed through a thickly settled section of the town, and because of its being badly polluted it was considered a danger to the health of the community. At a conference with the board it was decided to order the proprietors of the factories on the banks of the stream to remove their privies therefrom, so that the stream will receive no further pollution from this source. The proprietors are complying as quickly as can be reasonably expected.

Leominster. — Upon complaint that odors arising from a manure pit in the basement of a livery stable constituted a nuisance to the residents of the neighborhood, the State Inspector of Health made an investigation, and found that the manure was being removed from the basement. Other conditions about the place were excellent.

Lunenburg. — Unsanitary conditions existing about the men's privies at Whalom Park were investigated, and the matter was taken up directly with the superintendent of the street railroad, who has charge of affairs at the park. The use of the privies was immediately discontinued. Plans are under way for the provision of modern sanitary conveniences for men.

Sterling. — Faulty drainage, unsanitary privy and general unclean conditions existing on a farm place were investigated and called to the attention of the local health authority, with suggestions for changes. The matter is still pending.

Winchendon.— Filthy conditions about privies and drains existing at Springs Village were investigated and called to the attention of the local health authority, with suggestions for changes. A large overflowing cesspool, located between two houses, was connected, at the suggestion of the State Inspector of Health, with a covered drain which empties into the Millers River. Some slight changes were made about the privies.

An open drain immediately back of the Salvail house, which last year was found in a distinctly filthy condition, was very much improved.

Hubbardston. — Undrained land located in the center of the village, investigated last year and found a menace to the health of the people residing near it, has been properly drained.

Barre. — The faulty condition of drainage, faulty water supply and filthy privies existing at South Barre Village have been very efficiently removed. The overflow pipes of cesspools have been connected with a covered drain, which empties its sewage upon filter beds. The spring into which all the residents were dipping for their supply of drinking water has been provided with cement walls extending about 2 feet above the ground level, and a superstructure or roof of wood, making a reservoir (covered) of about 48 square feet. The river water has been disconnected with the dwellings and in its place spring water is piped into all the dwelling houses. All the vaults of the privies have been made tight and are receiving proper attention.

Factory and Industrial Hygiene.

Forty industrial establishments were inspected, 6 of which were inspected for the first time. In 13 establishments violations of the law were found, and orders requesting changes were issued as follows: —

To improve light,	1
To improve cleanliness,	1
To improve removal of dust,	4
To provide proper water-closets,	2
To provide sputum receptacles,	4
To provide first-aid outfit,	4
To provide washing facilities in foundries,	1
To provide fresh and pure drinking water,	1
Total number of orders complied with: —	
To improve light,	–
To improve ventilation,	1
To improve cleanliness,	4
To improve removal of dust,	2
To provide proper water-closets,	3
To provide sputum receptacles,	2
To provide first-aid outfit,	10
To provide pure drinking water,	–
To provide seats for women,	–
To provide washing facilities in foundries,	7
Relative to humidifiers,	1

The establishments examined may be classified as to their sanitary conditions as follows: —

Factories in which sanitary conditions were excellent,	11
good,	22
moderately bad,	6
distinctly bad,	1

Foundries. — Of the 12 foundries visited in Fitchburg, Clinton, Gardner and Barre, 10 were provided with good roof ventilation, 1 with large windows on three sides of the building and three ventilators in roof, which afforded excellent light and ventilation, and 1 with poor roof ventilation and poor light.

(*a*) *Chipping Castings.* — In one foundry this work was being done by 5 men employed at a bench in a small, poorly lighted and ill-ventilated room. In all other foundries visited it was done practically in the open. In those establishments in which several men were found at work, they were so arranged as to afford the best possible protection from injury from flying pieces of metal. In none were the men provided with glasses for the protection of their eyes, which appear to receive the greater number of injuries.

(*b*) *Tumbling or Milling of Castings.* — In 10 of the 12 foundries examined this work was done in small rooms in or near the foundry, and in all instances not more than 1 man was exposed to the dust given off, and only for a few minutes at a time. Immediately upon setting the machines in motion he would leave the room, not to return until he wished to cut off the power. In two of the foundries the tumblers were connected with suction pipes and blowers, and in 1 preparations were made to install an exhaust system.

(*c*) *Cleaning of Castings.* — In 9 of the 12 foundries the castings, after being taken from the molds, were cleaned by hand with brush having steel bristles. It is an extremely dusty occupation, yet none of the men doing this work were found to wear respirators. In 3 of 12 foundries the castings were cleaned with the sand blast. The men operating these machines were provided with helmets, gloves and respirators, but in only one instance were respirators worn. This method appears to be replacing the old method of cleaning castings by hand.

(*d*) *Dipping of Castings.* — In every instance this work was done during the night and after the men had left the shop.

(*e*) *Washing Facilities.* — In 7 of the 12 foundries examined, washing facilities were provided, some barely complying with the law, while in others good washing facilities were provided. Four had not provided such facilities because of there being no sewer connections, and 1 had failed to comply with the order issued upon the first visit.

Woolen Mills. — Of the 6 woolen mills examined, 2 were modern mills, exceptionally well lighted and well ventilated. In 1 of these, in which carding and wool washing were conducted, large fans were installed for the removal of dust and fumes from these departments. Four were rather old buildings, low studded, but in general well lighted and ventilated. In 2 of these, 2 basement workrooms were found poorly lighted and ventilated. In 1 of these 7 girls were employed inspecting the finished goods on the light side of the room, while on the dark side were located the washing machines. The air was distinctly musty. In 1 of the 6 mills artificial moisture was used for humidifying purposes. Fresh and pure water was being used in place of the polluted river water in use on the previous visit. Modern humidifiers were

installed. A record of the readings of the hygrometers and thermometers in the various work rooms was not kept, regulation of the degree of moisture being carried on in a haphazard manner.

(*a*) *Washing Facilities.* — In 3 mills good washing facilities were provided; in 3 no proper washing facilities were provided. In no mills were proper facilities provided for the care of outer garments of employees. The side walls were made use of for this purpose.

Straw Hat Factory. — This was a modern two-story and basement wooden building, well lighted and well ventilated, in which every consideration was shown for the comfort and health of the employees.

(*a*) *Sizing and Drying Rooms.* — The nature of work performed in these departments necessitates a temperature of about 100° to 115° F. for the easy running of the size and the drying of the hats after being sized. Two men are exposed to these excessive temperatures continuously. They say they enjoy good health and do not mind the heat. The men looked well and were apparently healthy. Good washing facilities were provided, and provision was also made for the care of outer garments of employees.

Celluloid Goods Establishments. — The buildings of the 2 factories examined were good, well ventilated and well lighted.

(*a*) *Dipping.* — In both establishments dipping in acetic acid was carried on for the purpose of putting a gloss upon the goods manufactured. This was done under large hoods, in one connected with suction pipes and blowers, in the other not so connected. In the latter the odor of acetic acid was strong in all of the workrooms, but in the dipping room itself the odor was so strong as to be decidedly irritating to the eyes and mucous membrane of the respiratory tract. Three young men were directly exposed to the fumes, and 7 girls indirectly exposed in an adjoining room.

(*b*) *Washing Facilities.* — In 1 establishment, except in the wet rub room, washing facilities were absent. No proper provision was made in either establishment for the care of employees' outer garments.

Machine Shops. — Of the 7 machine shops examined in Fitchburg, Gardner, Barre and Winchendon all were found to be well lighted and well ventilated. work being done in good buildings. One showed lack of general order, neatness and cleanliness, and the basement of this same establishment was found to be poorly lighted. Toilet and washing facilities in all were good, but in only 1 were lockers provided for the workmen's outer garments. Removal of dust from grinding wheels was generally found to be good.

Woodworking Establishments. — Of the 9 establishments examined in Ashby, Athol and Winchendon, 5 were old buildings, low studded, but fairly well lighted and ventilated. The new buildings were all well lighted and ventilated.

(*a*) *Removal of Dust.* — The mechanical means provided for the removal of dust were, in general, efficient. Since the previous visit two of the establishments installed exhaust systems for the removal of dust. In a tub and pail factory, hoppers, suction pipes and blower were in process of installation for the removal of dust from the turning and sanding machines.

(*b*) *Washing Facilities and Drinking Water.* — In none of the establishments examined were washing facilities found. Drinking water was in general not provided within easy access of workmen. Usually there was one faucet in some distant room or in the basement, in consequence of which the open bucket or jug was resorted to. No provision for the care of employees' outer clothing was noted in any of the shops examined. In some instances the men made closets for their own individual clothes; in others, the clothes were tucked away in a corner of the workroom.

Shoddy Mills. — Two shoddy mills were examined in Athol and Hubbardston. Both were well lighted, well ventilated and kept clean. Rags come already sorted in baled form to both mills. These are taken from bales and placed directly into picker machines, which tear and pick them into fine woolen fibers. From the machines the wool is blown into bins. The wool is then dyed, and dried on racks over steam pipes, which in 1 establishment are located in the dye house, in the other in a separate building. In 1 establishment, engaged in the manufacture of bedding, the rags are first subjected for about twelve hours to formaldehyde fumes for the purpose of disinfection.

(*a*) *Washing Facilities.* — In both mills washing facilities were poor, and no provision was made for the care of employees' outer clothing.

Tannery. — One tannery was examined in Winchendon. It was well arranged, well lighted and well ventilated. The old-fashioned method of tanning with tanbark was in operation.

Health of Minors in Factories.

Total number of minors seen and questioned, 134.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	11	10	24	19	6	5	2	77
Female,	4	8	17	11	10	5	2	57
Total,	15	18	41	30	16	10	4	134

Total number of minors found to be in ill health, 5.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	2	-	-	-	-	-	-	2
Female,	1	-	1	1	-	-	-	3
Total,	3	-	1	1	-	-	-	5

The following conditions of ill health were found: —

Anæmia,	3
Granular eyelids and conjunctivitis,	1
Deafness resulting from adenoids,	1

One of the minors found in ill health was employed in a damp basement in a woolen mill, and another was employed in the mule spinning room of a shoddy mill.

In 3 cases parents were notified of the ill health of their children, and each child was placed under the care of a physician. In 1 instance the minor, who had no parents, had previously suffered from a tubercular hip joint. He looked anæmic and somewhat emaciated. The attention of the employer was called to his condition, and the minor was given light, outdoor work.

Tenement Hygiene.

Five licenses were granted to make, alter, repair and finish wearing apparel intended for sale, in tenement workrooms, all of which were located in the town of Holden. One was inspected in West Boylston and 1 in Leominster, but the parties had discontinued the work and did not intend to take it up again. The licensee in each case was engaged upon woolen footwear for a mercantile establishment located in Worcester. The work in every instance was done in well-lighted, well-ventilated and clean homes.

Schoolhouse Hygiene.

During the year 33 schoolhouses were inspected, and the conditions found were reported to the State Board of Health.

Six of the schoolhouses were inadequately ventilated and 1 was overcrowded. In all the others ventilation was satisfactory. In 4 there were mechanical means for supplying fresh air, while in 21 gravity ventilating systems were in use.

Light was satisfactory in all the schools and exceptionally good in a few. In 2 schools several recitation rooms were found where light was moderately poor.

Proper and sufficient water-closets were provided in all the schoolhouses, except 3. In 1 building the accommodations were not sufficient, and in 2 buildings the existing water-closets were unsanitary.

In 2 schoolhouses inspected the attention of the local authorities was called to unclean conditions which were remedied.

Matters relating to Water Supply and Sewerage.

Analyses of water from two wells were made. One well was located in Athol and was used by 6 families; the other was located in Baldwinsville and was used in a hotel by upwards of one hundred people daily from all sections of the country. The analyses of the water of both wells showed gross pollution. Upon the suggestion of the State Inspector of Health the local

health authority of Athol condemned the well located in that town and requested the owner of the property to obtain another water supply as soon as possible.

Slaughterhouse Inspection.

Fifty-four slaughterhouses were examined in the city of Fitchburg and following towns: Ashburnham, Ashby, Athol, Barre, Boylston, Clinton, Oakham, Princeton, Dana, Holden, Gardner, Hubbardston, Lancaster, Leominster, Lunenburg, Rutland, Sterling, Templeton, Westminster and Winchendon. In the towns of Holden, Rutland and Winchendon 7 slaughterhouses not licensed were found to exist, in 3 of which evidence of slaughtering appeared. In the towns of Berlin, Bolton, Hardwick, New Braintree, Paxton, Royalston, Phillipston, Petersham and West Boylston no slaughterhouses were found to exist. Of the 54 slaughterhouses examined, 41 were licensed and 13 were not licensed. Of the latter, 2 had been refused a license, 5 had not renewed their license and 6 had not at any time made application for such license. Slaughtering was done in 3 of the 13 unlicensed establishments. None of the slaughterhouses were used by an indefinite number of unlicensed butchers from neighboring towns. In 1 instance it was found that an unlicensed butcher was having his stock slaughtered, he assisting in the work. In every instance it was found that the meat inspector was rarely present at the time of slaughter, and in 7 instances it was found that on being sent for he called upon the following day. In 2 instances it was found that the meat inspector was the licensee himself. In one instance it was found that meat not inspected in one town was removed to another and there inspected. In the city of Fitchburg and the following towns, Ashburnham, Ashby, Athol, Barre, Boylston, Clinton, Dana, Gardner, Hubbardston, Lancaster, Leominster, Lunenburg, Oakham, Princeton, Sterling and Winchendon, there is one meat inspector; in Templeton and Westminster two each, and in Holden four.

The establishments are classified as follows: —

Those which merit especial commendation,	–
Those which are at least reasonably satisfactory,	14
Moderately bad,	15
Distinctly bad,	25
Total,	54

Repeated visits were made to many of the establishments for the purpose of detecting any violation of the meat laws. Two beef carcasses were condemned by the State Inspector of Health by reason of their being tuberculous, also three foreparts of beef carcasses found to be tainted or in process of decay were condemned, and all were sent to a rendering company. Frequent conferences were held with the local health authorities of the various towns for the purpose of bringing to their attention the slaughtering and meat inspection laws, and the unsanitary conditions under which slaughter-

ing was carried on. In every instance the State Inspector of Health insisted upon the meat inspector's presence at the time of slaughter. Conditions under which slaughtering is done in Fitchburg, Boylston, Clinton, Princeton, Holden, Leominster, Lunenburg, Sterling, Templeton and Winchendon have been improved. New slaughterhouses have been constructed, since the investigation of the State Inspector of Health, in Sterling, Winchendon and Fitchburg. They are ideal buildings for this purpose, having good light and ventilation, walls and floor of cement, running water, and well-arranged refrigerator rooms. Two persons engaged in the slaughtering business without a license in the towns of Holden and Winchendon were required to make application for such license, which they did, and in each case a license was granted.

Health District No. 13.

Harvey T. Shores, M.D., *Northampton, State Inspector of Health.*

This district includes all of Franklin County and all of Hampshire County excepting the towns of Huntington, Middlefield and Worthington.

Diseases Dangerous to the Public Health.

During the fall and early winter an outbreak of poliomyelitis occurred in the district. There were 51 cases in all, most of them being in Franklin County. All of these cases were visited, some of them several times, and a detailed report of the investigation was submitted to the office of the State Board of Health.

Consultations with Local Boards of Health.

Problems continually present themselves in the 45 towns in the district, relating to contagious diseases, quarantine, disinfection of premises and local nuisances, with which the local boards of health are unable to deal. In 38 of the towns the boards of health are made up of the selectmen and the overseers of the poor, who possess little knowledge of health matters.

During the year consultations were held with the boards of health of all the towns, with the exception of 1. With many of the boards of health the consultations were frequent. Statistics and data were gathered relative to the organization and methods in use by the health boards in the district. Only 6 towns have special appropriations for health work; in the remaining 39 the small expense incurred is taken from the contingent fund. Five boards have paid agents and 13 have physicians connected with them. In 31 towns the boards of health keep physicians supplied with postal cards for the notification of infectious diseases. Only in 13 towns are release cultures for diphtheria required. In 10 towns no certificate of a physician is required before children can return to school after a contagious disease.

The methods of fumigating premises occupied by persons ill with contagious diseases are inefficient and lack uniformity. In 14 towns the fumigation is done by the boards of health; in 22, by the attending physician; in 4, by the undertaker; in 3, by the druggist, and in 4, by the occupants of the prem-

ises. The agent used was either formaldehyde gas or sulphur. In 7 towns the boards of health did not know what methods were employed. Thirty-four of the boards of health keep no records of their proceedings and only those of 2 towns have printed regulations. In only 5 towns is there a town physician and in only 3 is there a hospital. Less than one-half of the towns require vaccination. Only 6 towns have milk inspectors. Nearly all the towns have medical inspection of school children by physicians appointed by the school committee.

Factory Hygiene.

All the factories in the district were visited once and some twice. In general, conditions were found satisfactory. There seemed to be a general interest on the part of the management in the welfare of their employees. The superintendents know the operatives well. They are familiar with their home conditions and with their home life. They thus become interested in the operatives, and show a readiness to improve those conditions which are apt to be detrimental to their health. In all, 18 factories were inspected; 3 of these were first inspections and 15 were second inspections. In several instances objectionable conditions were noted. In some of the weaving rooms, where elastic webbing is made, the looms were found too close and crowded. In a basket factory visited considerable wood dust was noted, but the machines producing the dust were far apart and scattered over a large plant. In the hat factories visited some of the operatives were found exposed to intense heat from the process. This condition was somewhat improved by exhaust blowers, but is not yet entirely satisfactory.

Health of Minors in Factories.

Of the 807 minors seen and questioned only 4 were found in ill health,— 2 males and 2 females. In several establishments the minors were exposed to unfavorable conditions. In cutlery works minors are doing machine grinding, which is to some extent a wet process necessitating having the hands in water nearly all day.

In the wet stretching of silk in the silk mills there is much spattering of water, which keeps the clothes of the minors engaged in the process more or less wet from their hips down.

Total number of minors seen and questioned, 807.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	24	36	57	76	71	53	66	383
Female,	29	47	66	72	65	58	87	424
Total,	53	83	123	148	136	111	153	807

Total number of minors found in ill health, 4.

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	–	–	–	–	1	–	1	2
Female,	1	–	–	–	–	–	1	2
Total,	1	–	–	–	1	–	2	4

Number of physical examinations made, 17.

Tubercular family history,	7
Appearance of minor,	10
	17

The parents of 1 minor were notified of the minor's condition of ill health.

Schoolhouse Hygiene.

During the spring 20 schoolhouses were inspected, most of them located in Northampton and Williamsburg. This investigation was of short duration, as schools closed shortly after the investigation began. In many of the schoolhouses the ventilation was found to be entirely inadequate, and many of the water-closets were in bad sanitary condition.

Health District No. 14.

Herbert C. Emerson, M.D., *Springfield, State Inspector of Health* (succeeded by James V. W. Boyd, M.D., Springfield, Sept. 8, 1909).

This district includes all of Hampden County, and, in addition, the towns of Huntington, Middlefield and Worthington.

Diseases Dangerous to the Public Health.

There were no epidemics of diseases dangerous to the public health, with the exception of an outbreak of scarlet fever in a neighborhood involving adjacent portions of Springfield, Wilbraham and Ludlow. Investigation of this outbreak seemed to indicate that the disease had been spread by light, unrecognized cases and possibly by milk. In one instance a well child was found to be desquamating profusely in a family from which a case of scarlet fever had been removed to the hospital. There were a number of boarders at this house, and at the time in question three large milk cans were standing on the piazza on which this child was playing.

An investigation of 88 cases of infantile paralysis occurring in the western part of the State in 1908 was made, and the results of the investigation were submitted to the State Board of Health.

Consultations with Local Boards of Health.

Sixteen consultations were held with representatives of the boards of health of 10 cities and towns relative to the health of towns, the occurrence of diseases dangerous to the public health, the methods of boards of health in guarding the public health against tuberculosis and other infectious diseases, and the statute requirements for first-aid appliances and sputum receptacles in factories and workshops.

Factory Hygiene.

One hundred and twenty-eight visits were made to industrial establishments. Forty-five of these were visited for the first time. In 6, no violations of the law were found; in 39, orders were issued requesting compliance with the law. Thirty-five of the orders were complied with. In the 83 factories reinspected violations of the law were found in 5, and written orders were issued requesting changes. The total number of orders issued were 78, as follows: —

To provide sputum receptacles,	41
To provide pure drinking water,	6
To provide first-aid outfit,	1
To provide proper closets,	15
To improve removal of dust,	6
To improve ventilation,	4
To provide toilet facilities for foundries,	2
To prevent spitting,	2
To improve cleanliness,	1

The total number of orders complied with were 57, as follows: —

Sputum receptacles provided,	33
Pure drinking water provided,	5
First-aid outfit provided,	1
Proper closets provided,	12
Improved removal of dust,	2
Improved ventilation,	1
Improved toilet facilities for foundries,	1
Spitting prevented,	2

The following orders, previously issued to the 83 establishments which were reinspected, were complied with as follows: —

Sputum receptacles provided,	63
Pure drinking water provided,	6
Proper closets provided,	23
Improved removal of dust,	3
First-aid outfit provided,	3
Improved ventilation,	2
Closets for foundry provided,	2
Spitting prevented,	2

In general, the reinspection showed a marked improvement over the conditions first seen. Whitewash had been used very extensively in many factories to aid the cleanliness and light of the rooms. More than thirty new water-closets were installed as the result of orders to provide proper water-closets in 13 factories, in some of which the toilet facilities, particularly for men, were disgraceful.

While there were numerous violations of the statutes in the factories examined, the general sanitary condition of all the factories was good. The large silk and thread mills particularly were in excellent condition. In 1 thread mill the ventilation of the weave rooms was excellent. An investigation showed that during the hot weather the temperature of these rooms was 8° less than that of the outside air. This mill was further provided with water-closets near the center of the weave room, which were of the most modern type and ventilated by exhaust fans. The dressing room of one of the thread mills was found to have a necessarily high temperature, and improvements were already under consideration for attempting to remove as much of the hot air as was possible. The only rubber factory inspected was found to be in excellent condition. One room was found in which there was considerable dust from the buffing wheels, which were not provided with dust-removal appliances. The necessity of providing such appliances was urged upon the owners, and during the next few months it was found that it would be possible to do away with these buffing wheels.

Health of Minors in Factories.

A total of 2,592 minors were inspected. Questions were asked as to their health, length of time they had been at work, the health of their nearest relatives, with especial reference to whether any of the minor's family had had tuberculosis. All those minors with a family history of tuberculosis and those that did not appear to be in good health were subjected to a physical examination. The following table shows the sex and age of all the minors seen and questioned: —

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	79	154	153	136	121	140	97	880
Female,	139	213	285	297	290	274	214	1,712
Total,	218	367	438	433	411	414	311	2,592

Eight and four-tenths per cent. of all the minors were fourteen years of age and 56 per cent. were found to be under eighteen years of age. Fifty-four minors gave a family history of tuberculosis. In 8 instances a member of the family was ill at the time with this disease.

Of the 210 minors subjected to a physical examination 57 were found in

good health and 153 presented some abnormal condition. The following table shows the conditions found and the age and sex of each minor who was given a physical examination: —

	Male.							Female.							Totals.
	Age.							Age.							
	14	15	16	17	18	19	20	14	15	16	17	18	19	20	
Poor development and under weight.	8	10	14	5	4	3	–	4	11	1	3	1	2	–	66
Poor development and anæmia,	8	10	6	3	3	–	1	–	1	3	1	1	4	1	42
Anæmia,	8	3	2	3	–	1	–	2	1	3	2	1	–	–	26
Enlarged tonsils and adenoids,	1	–	1	–	–	–	–	–	1	1	–	–	1	–	5
Poor development, under weight and anæmia.	2	–	–	–	–	–	–	–	–	–	1	–	–	–	3
Under weight,	–	–	2	–	–	–	–	–	–	–	–	–	–	–	2
Marked anæmia,	–	–	–	1	–	–	–	–	–	–	–	–	1	–	2
Anæmia and under weight,	–	–	1	–	–	–	–	1	–	–	–	–	–	–	2
Granular eyelids,	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Heart disease and adenoids,	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
Undersized, chicken breasted,	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Poor development, under weight, deaf in right ear.	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Malnutrition, gland in neck, obstruction of nostril.	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Totals,	28	24	28	12	8	4	1	7	14	8	7	3	8	1	153

It was found to be impossible in almost any mill to give the minor a thorough and careful physical examination, on account of the inability to find a room which was free from noise. The physical examination made consisted in a careful inspection of the patient, including an inspection of the mouth and chest. The use of the stethoscope was practically prohibited by the noise of the factory.

The total number of minors seen and examined from Nov. 1, 1907, to Sept. 1, 1909, was 6,767, of which the age and sex is shown below: —

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	185	347	407	487	475	515	357	2,773
Female,	271	428	592	708	725	708	562	3,994
Total,	456	775	999	1,195	1,200	1,223	919	6,767

Of this number, 6.7 per cent. were fourteen years of age and 65 per cent. were under eighteen years of age. Four hundred and eighty-one minors were subjected to a physical examination, either because of their personal appearance or a tubercular family history, and 276 were found to present

some abnormal condition. The abnormal conditions found were almost entirely malnutrition, and there were but 10 instances in which the minor was found to have organic disease. Tuberculosis in a minor was found but once, but it was ascertained that 2 other minors who left their employment after the first inspection developed tuberculosis. Of the total number of minors showing some abnormal condition 89 per cent. were under eighteen years of age and 27 per cent. were fourteen years of age. It thus appears that conditions of ill health are to be found in by far the greater proportion among minors under eighteen years of age, at the time of life when injurious influences are most likely to affect the health of the growing youth. It was noted that abnormal conditions in minors fourteen years of age were found to be nearly double the number in males as in females. In 1 mill certain rooms were found in which small boys were particularly desired, and these were hired by the foreman and paid by him, and their names did not appear on the pay roll of the company. The work was not hard, but the room was hot and moist, conditions tending to ill health in persons of this age. The matter was brought to the attention of the officers of the company, who promised to investigate this condition at once and take steps to correct any abuses.

The conditions in which the minors are employed in most factories and workshops may be divided into two classes, depending on the age of the minor. As a rule, minors from eighteen to twenty years of age perform practically the work of adults, and are treated as such. The other class consists of minors under eighteen years of age, who are usually employed at light work. In general, the sanitary conditions under which most of the younger minors are employed are good. The rooms are usually large, well ventilated and lighted and are kept clean. The toilet arrangements for the two sexes are usually well separated and are sufficient. The instances are rare in which the younger minors have been employed in any room where the sanitary conditions are very poor, such as exposure to dust, high temperatures and poor light and ventilation. No instances were found in which the work of the younger minors appeared to be manifestly unsuitable for them, excepting one, where boys were employed to carry material into a room filled with strong nitric and sulphuric acid fumes.

Hygiene of Public Buildings and Schoolhouses.

Ludlow. — Inspection of 3 schools in Ludlow showed that 2 of them were in excellent condition. Investigation of the high school in Ludlow showed that the schoolrooms were inadequately ventilated, and orders were issued for better ventilating provisions. On reinspection it was found that a contract had geen given for a new high school building.

Russell. — Inspection of a schoolhouse in Russell showed that the toilet facilities, consisting of an earth closet, were in very poor sanitary condition, and it was stated that objectionable odors arise from this earth closet. As the result of a written order issued by the State Inspector of Health to the school committee the old sanitaries were removed and new satisfactory earth closets were installed.

Inspection of the Palmer High School, in which proper ventilating provisions had been ordered, showed that a contract had been let for an addition to and the remodelling of this high school building.

A reinspection of a public building in Springfield, in which better ventilating facilities were ordered, showed that the order had been complied with, and the ventilation of the room in question was much improved.

Sept. 8, 1909, to Nov. 1, 1909.

The appointment of Dr. James V. W. Boyd as State Inspector of Health in place of Dr. Emerson, resigned, was confirmed on Sept. 8, 1909.

The work during these two months consisted mainly in an inspection of some of the factories which were considered to be among the best in the district, in order to obtain and fix a standard for the work. Twenty-six establishments were inspected.

In 2 textile mills 163 minors were seen and questioned. Of 25 physical examinations made, 1 minor was found to have tuberculosis of the left hip joint and of the lungs, and 1 mitral disease of the heart; 1 boy was deaf and dumb. Other conditions found were as follows: chronic conjunctivitis, adenoids and enlarged tonsils and old tubercular scar in the neck. One minor was pale and habitually breathed through the mouth. Two others, who were pale, were below the average in height.

Two alleged local nuisances were investigated. One was referred for action to the local board of health.

Health District No. 15.

Lyman A. Jones, M.D., *North Adams, State Inspector of Health.*

This district includes all of Berkshire County.

Diseases Dangerous to the Public Health.

Efforts begun last year to secure a fuller report of cases of tuberculosis were continued during the year. Nine physicians and a district nurse were interviewed relative to this matter, which, in addition, has been repeatedly the subject of informal conversation with physicians and others.

An examination was made of the number of cases of tuberculosis reported and the number of deaths from the diseases during the last three years in three of the largest places in the district, — Adams, North Adams and Pittsfield. It would seem from the records that in Adams and Pittsfield cases are more fully reported, while in North Adams the cases are not so well reported.

Twelve cases of tuberculosis were investigated in detail.

During the year anti-tuberculosis societies were formed in Adams and Great Barrington, and a movement is now in progress in North Adams for the establishment of a day camp under the auspices of the Young Men's Christian Association.

With the exception of 5 cases of typhoid fever in Great Barrington and some cases in Pittsfield and North Adams, the district was practically free from this disease, save for an occasional isolated case here and there. During September and October Pittsfield had 18 cases, and North Adams, during August, September and October, had 23 cases. Many of these were investigated in detail, without as yet disclosing evidence of any common source of infection.

The typhoid carrier case mentioned in the preceding annual report was further under observation, and a full account of the case was submitted to the State Board of Health. A brief summary of the case follows: —

Since 1902 there has been a somewhat frequent occurrence of typhoid fever in North Adams. Investigations were made from time to time to locate, if possible, any common source of infection. Suspicion was directed to a dairy owned by Mr. L. While the L. dairy never produced over one-one hundredth part of the milk consumed in North Adams, one-fifth of all the typhoid fever cases were consumers of that milk. Frequent investigations of the L. dairy did not disclose any source of infection. Recent visits, however, brought out the fact that Mr. L.'s daughter, a middle-aged woman, had had typhoid fever in New York State over fifteen years ago. A sister had gone from her home here to care for this daughter, contracted the disease and died, while this daughter recovered and soon returned to her father's home in Clarksburg, bringing two children with her. Here she has lived since. During this fifteen years she has had five children. All seven children are well, and none of them ever had any serious illness. The mother has had no other illness beyond what was associated with child bearing.

This information led to the taking of a Widal test, which was positive. Specimens of the urine and feces were examined at three different times. The first examination resulted in the finding of bacilli which closely resembled the paratyphoid bacillus. The second and third examinations were negative.

Since May, 1908, to the present time (October, 1909), there have been no cases of typhoid fever which could be traced to this source. This present season the production of milk for other than their own family use has been discontinued.

The absence of cases of typhoid fever from this source previous to 1902 is explained in that till then no milk was produced on the farm except for their own family use. At that time, additional cows were purchased, and the milk was sold to Mr. C., who sold the milk in North Adams. That the cases due to this infection were irregular in their appearance and number seems easily explainable in considering the probable mode of infection of the milk. As a rule, Mr. L.'s daughter has had nothing to do with the milk, except that the milk was taken into the kitchen for straining, and the cans were washed there. Occasionally the daughter volunteered to assist her father in the handling of the milk or utensils.

During the fly season further opportunity for infection occurred, in that the privy was not far away from the house, and was not screened from the

flies, while the cans were left to dry near the house, where the flies found ready access to them.

In these two ways was there a possibility of infecting the milk produced in this dairy. Since May, 1908, no cases of typhoid fever which could be traced to this source have occurred, as the production of milk for other than their own family use has been discontinued.

Nearly 150 cases of scarlet fever have been reported in the district. The cases were reported from 15 cities and towns, and occurred quite generally throughout the year.

About 50 cases of diphtheria from 8 cities and towns were reported in the district during the year. There was nowhere any special outbreak of the disease. During the year Adams and Williamstown made regulations requiring negative cultures to release diphtheria cases from quarantine. This precaution is now in force in all the large towns in the district.

Measles was present in 8 cities and towns. In the late winter and early spring there were 25 cases in Sheffield, and at the same time there were over 450 cases in Great Barrington. A special investigation of this epidemic afforded the following explanation of its origin: —

During October, 1908, there were 6 cases of measles reported in Housatonic, in the north part of Great Barrington, and during November 41 additional cases were reported. In Great Barrington during October 2 cases were reported, and during November (19 and 23) a like number was reported. There were no further cases of measles until January 9 of this year, when 9 cases were reported. During the remainder of the month and February many cases were reported daily, the maximum being attained in February, while the epidemic quickly died out in March, when 29 cases were reported.

It was found that the infection was spread originally by a child from out of town, who attended a Christmas festival at one of the churches just as he was ill or about to become ill with measles. Further cases followed promptly early in January. The extent of the epidemic was in part due to the fact that there had been no general outbreak of measles in Great Barrington for about seven or eight years.

As a precautionary measure 22 cases of varicella were investigated in North Adams, in company with the local health officials, at a time when smallpox was present in nearby towns in southern Vermont. At the same time letters were written to 29 physicians asking them to be on their guard against the disease, and to report promptly any suspicious cases.

Fifty-two cases of anterior poliomyelitis have been reported in the district. Thirty-one of the above cases were investigated in detail, and a report of the investigation was submitted to the State Board of Health.

A number of cases of sore throat occurring among the employees of a hotel were investigated. Several cases of a mild disorder of the bowels were investigated in a small mill town. Neither of the outbreaks proved to be of any special significance.

Consultations with Local Boards of Health.

The general sanitary condition of 12 towns in the district has been ascertained through conference with the local health authorities. No summary of this work will be attempted until such information has been secured for the whole district.

During the year many interviews were held with local boards of health or individual members of the same, with regard to health matters.

It is gratifying to find that a greater interest in health subjects was evidenced in many ways, and that there was an added readiness on the part of physicians to take part in matters concerning public health.

Local Nuisances.

A nuisance relating to unsanitary tenements in Sheffield was brought to the attention of the local health authorities, with the recommendation that certain features be corrected at once; and the opinion was expressed that the board would be justified in condemning the buildings in question. Up to the present time such action has not been taken.

A portion of a rendering plant previously complained of was reinspected. Improvements were noted and a decided effort to remedy annoying features was evident.

With the increased interest of the past few years in out-of-door life and sports, camps and camp communities are springing up and rapidly increasing in number and size. While the sanitary surroundings of a single isolated camping party may reasonably be left to the individual, it is another matter entirely when many such camps for a community, or when large numbers of individuals coming and going frequently, are gathered in a single camp.

Five such camps or communities were visited during the season. A surprising lack of attention to sanitary conditions was observed. In one school-camp the closets, located within 30 or 40 feet of the camp kitchen, were so constructed that it was impossible to clean them or to prevent the free access of flies. In another camp very similar conditions existed. In one camp, frequented by many people, the privy drained into that part of a pond used for swimming purposes, while the water supply was taken from a well at the roadside, only 12 or 15 feet away from a barn and a manure pile.

These conditions were all promptly remedied, and in several instances dry earth closets were arranged.

In certain districts it may be advisable for local boards of health to adopt uniform regulations for camp sanitation.

Factory Hygiene.

Fifty-five visits were made to 35 establishments, in 20 of which the minors were interviewed and examined. Seven small establishments were visited for the first time.

Changes for efficient removal of dust were ordered in 1 establishment, proper water-closets in 3 and first-aid outfits in 2. In each of the 3 establish-

ments where orders relative to proper water-closets were issued conditions were improved.

In portions of 1 large cotton plant there has been considerable complaint from time to time regarding the condition of the water-closets. This was investigated and discussed with the owners. In some portions of the plant, entire new plumbing has been installed. With regard to the closets in question, changes were made providing for more adequate outside ventilation, instead of ventilating into the workroom, and conditions are thereby greatly improved.

In general, the owners and managers of industrial establishments have displayed an increasing willingness to listen to requests, and to co-operate in placing their establishments in the best possible condition to conserve the health of their employees.

Health of Minors in Factories.

One thousand six hundred and eleven minors were interviewed and 69 minors were examined in 20 manufacturing establishments, located in 8 towns.

The following table gives the details concerning the minors interviewed and examined: —

	Age.							Total.
	14	15	16	17	18	19	20	
Male,	71	100	125	138	134	98	100	768
Female,	55	97	143	165	145	117	121	843
Total,	126	197	268	303	279	215	221	1,611

Number of minors in ill health (girl of sixteen),		1
Number of physical examinations made,		69
Tubercular family history,	60	
Previous personal history,	4	
Appearance of minor,	5	

With one exception the various establishments in which minors were employed to any extent were in good or excellent condition. In nearly all instances the buildings were of brick, of modern construction, well lighted, adequately ventilated and kept clean.

The water-closets, in general, were of recent type, sufficient in number and satisfactory. In several places they were worthy of especial commendation. In 1 plant there were several caretakers, whose sole duty was to keep the toilet rooms in proper condition.

In 1 woolen mill, where 19 minors were employed, the building was old, and, notwithstanding repairs and alterations, was far from satisfactory. It is probable that nothing short of a new building would make conditions what

they should be. This mill was far below the standard of 2 other mills belonging to the same company, where conditions were reasonably satisfactory.

Among the minors employed but 1 case of actual illness was discovered. This was a girl of sixteen, with pulmonary tuberculosis, employed in the rag room of a paper mill. Her parents were notified and likewise the physician whom she had been consulting for a "cough." The matter was informally discussed with the management of the mill, and as a result the young woman was sent to the State Hospital for Tuberculosis at Rutland, where she was recently reported to have made excellent progress toward recovery.

From another mill under the same management the superintendent of a rag room was sent to Rutland.

At different times attention has been directed to minors employed in cotton mills. The minors in question were undersized and under weight.

In 3 large cotton mills 889 minors were employed, — 427 males and 462 females. Three hundred and twenty-six of these minors — 148 males and 178 females — were under sixteen years of age. A special study of this latter group showed that 100 of the number — 60 males and 40 females — were undersized and under weight.

The establishments where these minors were employed were modern mills, of good construction, in good or excellent condition. The lighting and ventilation were for the most part satisfactory. The largest number of minors worked in the spinning rooms, where the nature of the work permitted employing younger help; the others worked in the carding and weaving departments.

Notwithstanding the fact that 70 of these minors worked in rooms where the processes of manufacture produced a varying amount of dust, it does not seem probable that the nature of the employment is an important factor in their lack of growth and development. None of them have been at work much over two years, and 67 of the 100 have been at work but little over a year, or less. Hence, it is a fair inference that their physical condition depends upon circumstances other than those connected with their work. Unquestionably very many of these would be better off if they were engaged in outside employment or were attending school, where they might develop more fully and attain an added degree of ruggedness. In the absence of ill health and physical unfitness, however, no action has been taken with regard to this class.

In 1 large cotton mill it was practically impossible to make any satisfactory physical examination of minors because of the noise of the machinery.

In general, the health of minors employed in this district was found to be good.

Schoolhouse Hygiene.

During June, 8 schoolhouses were inspected in considerable detail, and a full report of each inspection was submitted. These schools, with one exception, were located each in different towns, and were selected for inspection as representing buildings of different types, the schoolhouse of the city and of the country, old and new buildings.

Two of these buildings were of wood, 6 of brick. One building was heated by a stove, 2 by hot air, 1 by direct steam radiation, 2 by a combination of both.

Ventilation was provided by means of the windows in 1 instance, by means of a fan in another, by gravity alone in 1 building, and by gravity with heat in the foul-air shaft to secure circulation in 5 instances.

Overcrowding was found in 3 rooms.

The light reached the pupils from the left side in 8 rooms, from behind and the left side in 27, from behind and the right side in 8, from behind and both sides in 3, and from the right and left sides in 2 rooms.

In 1 schoolhouse the privies were in a rather poor condition; in 7, the closets were modern and reasonably satisfactory.

One school building, Williams Academy, was found entirely unsuited for school purposes. Owing to its age and arrangement satisfactory improvements are impossible. A new building is urgently needed.

Matters relating to Water Supply and Sewerage.

The sources of water supply of the town of Cheshire were examined late in the summer. The opportunities for contamination of the old reservoir were many, and even the newer source of supply on Kitchen Brook was exposed to pollution from stables and from pigs and cows high on the mountain side, whence small brooks feed into the main brook. The matter was reported to the engineering department of the State Board of Health for further action.

Of private supplies, one in the town of New Marlborough was investigated on account of a case of typhoid fever. The others, seven in number, were sources whence a hotel, a manufacturing company or a considerable number of people desired to secure water. Five of these supplies were found to be objectionable.

For several years there has been regularly a shortage of water in North Adams during the late summer or fall, so that the use of the water has been restricted for some purposes, even though the artesian wells on Ashland street, the use of which has been repeatedly condemned, were in commission. At the suggestion of the engineering department, 30 officials, citizens, business men and others, were interviewed and the urgent need of an additional source of supply presented to them. As yet the city has taken no action in the matter.

In continuation of the work begun last year, 37 officials and others were interviewed concerning the necessity for removing the city's sewage from the Hoosick River. In May the city council of North Adams appropriated the sum of $500, to be used in a study of the problem and to secure the needful preliminary information.

Sources of Ice Supply examined. — In one instance ice was taken from a pasture flooded during the winter by a small brook, which received some domestic drainage directly and all the general drainage from an area occu-

pied by 8 or 9 farmhouses and accompanying buildings along its banks. The use of this source of supply was discontinued.

In another instance an enterprising farmer had located a large number of pigs in a pen through which ran a brook supplying in part a small reservoir from which the main ice supply of the town was obtained. The location of the pigpen was changed.

Slaughterhouse Inspection.

In the following 10 towns there are no slaughterhouses and no licenses to slaughter: —

Alford.	New Ashford.
Clarksburg.	Peru.
Florida.	Richmond.
Hancock.	Savoy.
Mt. Washington.	Tyringham.

In the cities and towns below mentioned, 46 places of slaughter were visited. Eighteen of the places were in separate buildings, while 26 were in a portion of the barn or other building.

Adams.	New Marlborough.
Becket.	North Adams.
Cheshire.	Otis.
Dalton.	Pittsfield.
Egremont.	Sandisfield.
Great Barrington.	Sheffield.
Hinsdale.	Stockbridge.
Lanesborough.	Washington.
Lee.	West Stockbridge.
Lenox.	Williamstown.
Monterey.	Windsor.

Thirty-five places in the cities of North Adams and Pittsfield, and the towns of Adams, Cheshire, Egremont, Great Barrington, Lee, Lenox, Monterey, New Marlborough, Otis, Sandisfield, Sheffield, Stockbridge, West Stockbridge and Williamstown, are licensed.

Eleven places in the towns of Dalton, Hinsdale, Lanesborough, Lee, Washington, West Stockbridge and Windsor, and in the city of Pittsfield, are not licensed.

Granted that slaughtering should be carried on in a manner as little offensive as possible, in a suitable place, properly cared for, it is at least desirable that a place of slaughter should have a floor, and preferably walls as well, of non-absorbent material; that there should be an abundant supply of water immediately at hand; that there should be drainage and satisfactory disposal of offal; and that the place should be kept clean.

On this basis there is not a single excellent place of slaughter in the dis-

trict. Some 10 or 12 places are reasonably satisfactory, while the remainder are either moderately or distinctly bad. Three or four of these are simply intolerable.

An explanation of this is found in the fact that frequently the licenses are issued as a matter of form, simply to conform with the law. No effort is made in advance to ascertain whether the place is in any way suitable for the purpose, or whether it is properly kept. If previous inspection is made, the lines are not sharply drawn.

An estimate as to the amount of slaughtering in the cities and towns of the district was submitted on Dec. 4, 1909. This estimate, based on information obtained at the time of visiting the slaughterhouses, and computed from the number of animals said to be dressed weekly, indicates that over 10,000 animals, chiefly sheep, calves and swine, are slaughtered annually.

The inspection and stamping of carcasses at the time of slaughter are decidedly lax. The inspection of beef carcasses at the time of slaughter appears to be quite general, but as a rule this does not extend to the smaller animals, when other slaughtering is not in progress, and is practically never carried out when such slaughtering is done on the farms where the animals are raised.

In some instances carcasses of veal are brought to market and there stamped by the inspector before being offered for sale, and in many other instances are not inspected and not stamped. This is the result of ignorance, indifference or misinterpretation of the law on the part of those concerned.

In the larger places the inspectors are usually graduates in veterinary medicine, who carry on the practice of their profession, and who take the inspection work as a side issue. In the smaller towns the inspector is usually a farmer, or some tradesman or workman without special qualification for the work. The pay is usually small, ranging from $10 to $20 annually, to $35 to $50 per month in two or three instances.

In a considerable portion of the district, especially in the southern part, inspection is carried on under a good deal of difficulty. Large areas are entirely shut away from means of communication except by team, over roads that are hilly and often heavy to travel. The population is small and scattered. The slaughterhouse is several miles distant from the inspector. Hence, it is very easy for one so disposed to butcher and sell the carcass, with no one the wiser.

This is especially true in some towns bordering on adjoining States, where it is said cattle are frequently brought from without the State, butchered, and the carcasses sold, also without the State, inspection being dispensed with.

Considerable meat is sold by peddlers from out of the State. Some towns, such as Hancock and Mt. Washington, are almost wholly dependent upon such sources of supply, while others, like Williamstown and New Marlborough, receive a portion of their supply in such manner. Meat supplied in this way has undergone no inspection.

The conditions found in this district would seem to warrant the conclusion that there will be no satisfactory slaughtering and inspection until a central

slaughterhouse is established by each town or by several towns jointly, where all slaughtering must be done, whether done by dealers, farmers or individuals. In no other way can the smaller towns hope to secure qualified inspectors and thorough inspection.

No diseased carcasses were found, nor have any legal proceedings been undertaken.

In three instances improvements were made in slaughterhouses.

THE SUPERVISION OF THE COLLECTION, TRANSPORTATION AND DISPOSAL OF GARBAGE IN THE CITIES AND TOWNS OF MASSACHUSETTS.

A study of the collection, transportation and disposal of garbage in the cities and towns in the Commonwealth led to the following classification of procedures. By garbage is meant the refuse animal and vegetable matter from the kitchen.

Class A includes no cities. This class comprises 247 towns which neither issue licenses nor require permits for the collection or transportation of garbage. No city or town in this class collects or regulates the disposal of garbage. It is customary for the householder to dispose of his garbage by one of the following ways: (*a*) burning; (*b*) burying; (*c*) placing on a dump; (*d*) feeding to swine; (*e*) giving to a private collector, who usually feeds to swine or fowl. The board of health interferes only when a nuisance is created by a householder or a private collector.

It will be noted that many of the towns in this class are situated in the middle and western portions of the State. In Hopedale and Ludlow, where there is no municipal collection or control of garbage, the larger part is collected by manufacturing concerns which provide homes for many of the residents of the towns.

A list of the towns in this class is given in Table A.

TABLE A.

[The towns in this table exercise no supervision over garbage, they neither collect it nor regulate its transportation and disposal.]

Abington.	Avon.	Blackstone.
Acton.	Ayer.	Blandford.
Acushnet.	Barnstable.	Bolton.
Agawam.	Barre.	Bourne.
Alford.	Becket.	Boxborough.
Amherst.	Bedford.	Boxford.
Andover.	Belchertown.	Boylston.
Ashburnham.	Bellingham.	Brewster.
Ashby.	Berkley.	Brimfield.
Ashfield.	Berlin.	Brookfield.
Ashland.	Bernardston.	Buckland.
Auburn.	Billerica.	Burlington.

TABLE A — *Continued.*

Canton.	Granville.	Merrimac.
Carlisle.	Greenwich.	Methuen.
Carver.	Groton.	Middlefield.
Charlemont.	Groveland.	Middleton.
Charlton.	Hadley.	Millbury.
Chatham.	Halifax.	Millis.
Chelmsford.	Hamilton.	Monroe.
Cheshire.	Hampden.	Monson.
Chester.	Hancock.	Monterey.
Chesterfield.	Hanover.	Montgomery.
Chilmark.	Hanson.	Mt. Washington.
Clarksburg.	Hardwick.	Needham.
Cohasset.	Harvard.	New Ashford.
Colrain.	Harwich.	New Braintree.
Conway.	Hatfield.	New Marlborough.
Cummington.	Hawley.	New Salem.
Dalton.	Heath.	Newbury.
Dana.	Hinsdale.	Norfolk.
Dartmouth.	Holbrook.	North Andover.
Deerfield.	Holden.	North Brookfield.
Dennis.	Holland.	North Reading.
Dighton.	Holliston.	Northborough.
Douglas.	Hopedale.	Northfield.
Dover.	Hopkinton.	Norton.
Dracut.	Hubbardston.	Norwell.
Dunstable.	Huntington.	Oakham.
East Bridgewater.	Kingston.	Orleans.
East Longmeadow.	Lakeville.	Otis.
Eastham.	Lanesborough.	Oxford.
Easton.	Lee.	Paxton.
Edgartown.	Leicester.	Pelham.
Egremont.	Lenox.	Pembroke.
Enfield.	Leverett.	Pepperell.
Erving.	Lexington.	Peru.
Essex.	Leyden.	Petersham.
Florida.	Lincoln.	Phillipston.
Foxborough.	Littleton.	Plainfield.
Freetown.	Ludlow.	Plainville.
Gay Head.	Lunenburg.	Plymouth.
Georgetown.	Lynnfield.	Plympton.
Gill.	Mansfield.	Prescott.
Goshen.	Mashpee.	Princeton.
Gosnold.	Medfield.	Randolph.
Grafton.	Medway.	Raynham.
Granby.	Mendon.	Reading.

TABLE A — *Concluded.*

Rehoboth.	Sterling.	Wellfleet.
Richmond.	Stockbridge.	Wendell.
Rochester.	Stoughton.	West Boylston.
Rockland.	Stow.	West Bridgewater.
Rockport.	Sturbridge.	West Brookfield.
Rowe.	Sudbury.	West Newbury.
Rowley.	Sunderland.	West Stockbridge.
Royalston.	Sutton.	West Tisbury.
Russell.	Templeton.	Westford.
Rutland.	Tewksbury.	Westhampton.
Sandisfield.	Tisbury.	Westminster.
Sandwich.	Tolland.	Westport.
Savoy.	Topsfield.	Westwood.
Seekonk.	Townsend.	Weymouth.
Sharon.	Truro.	Whately.
Sheffield.	Tyngsborough.	Whitman.
Shelburne.	Tyringham.	Wilbraham.
Sherborn.	Upton.	Williamsburg.
Shirley.	Uxbridge.	Williamstown.
Shrewsbury.	Wales.	Wilmington.
Shutesbury.	Walpole.	Windsor.
South Hadley.	Warren.	Worthington.
Southampton.	Warwick.	Wrentham.
Southborough.	Washington.	Yarmouth.
Southbridge.	Wayland.	
Southwick.	Webster.	

Class B includes 2 cities and 29 towns which supervise, to a certain extent, the transportation of garbage by regulations or permits, or both. Two cities, Gloucester and Marlborough, and 19 towns not only have regulations but also require and issue permits for the transportation of garbage. Nine towns have made regulations and 1 town issues permits for the transportation of garbage. The form of regulation adopted by the various towns does not vary greatly. For example, Bridgewater requires that garbage shall "be conveyed in a covered, water-tight cart or wagon." Wenham requires that "no person shall bring any swill or house offal within the limits of this town except in suitably covered wagons."

In 2 cities and 20 towns which issue permits for the transportation of garbage it is customary to give the permit to any person who may apply for it, provided the licensing board is satisfied that the applicant will transport the garbage properly. Scituate, however, limits the number of permits to three.

No city or town in this class collects or regulates the disposal of garbage. In the town of Bridgewater much of the garbage is collected under the supervision of the Village Improvement Society.

A list of the cities and towns in this class is given in Table B.

TABLE B.

[The cities and towns in this table do not collect garbage but they do exercise a certain amount of supervision over the manner in which it is carried through the streets, either by regulations or by issuing permits or by both.]

	Regulations only.	Permits only.	Regulations and Permits.
Attleborough,	-	-	Yes.
Bridgewater,	Yes.	-	-
Concord,	-	-	Yes.
Danvers,	-	-	Yes.
Fairhaven,	-	-	Yes.
Falmouth,	-	Yes.	-
Franklin,	-	-	Yes.
GLOUCESTER,	-	-	Yes.
Great Barrington,	Yes.	-	-
Hudson,	-	-	Yes.
Ipswich,	-	-	Yes.
Lancaster,	-	-	Yes.
Manchester,	-	-	Yes.
Marblehead,	-	-	Yes.
MARLBOROUGH,	-	-	Yes.
Milford,	Yes.	-	-
North Attleborough,	-	-	Yes.
Northbridge,	Yes.	-	-
Palmer,	Yes.	-	-
Peabody,	-	-	Yes.
Provincetown,	Yes.	-	-
Scituate,	-	-	Yes.
Somerset,	-	-	Yes.
Stoneham,	-	-	Yes.
Swansea,	-	-	Yes.
Wakefield,	-	-	Yes.
Ware,	Yes.	-	-
Wareham,	-	-	Yes.
Wenham,	Yes.	-	-
Westborough,	Yes.	-	-
Weston,	-	-	Yes.
Total, 2 cities and 29 towns,	9	1	21

Class C includes cities and towns which collect, and, to a greater or less extent, regulate the transportation and disposal of garbage. Of this class 31 cities and 42 towns collect garbage by the city or town officials or by contractors employed or authorized for the purpose. In 1 city, Boston, a large part of the garbage is collected by the sanitary department and the rest by four contractors. In 13 other cities and 5 towns it is collected by the municipal department, while in 17 cities and 37 towns it is collected by contractors.

While many of the cities and towns collect all the garbage, others, *e.g.*, Taunton and Woburn, only collect in the central or thickly settled portions. Certain towns on the coast, *e.g.*, Hull, Oak Bluffs and Salisbury, collect only during the summer months, when their population is much increased by summer residents.

Five cities and 10 towns have regulations, 4 towns issue permits and 26 cities and 23 towns issue both regulations and permits, while 5 towns neither make regulations nor issue permits, for the transportation of garbage. As to issuing permits for the transportation of garbage, 13 cities and 20 towns issue the permit either to the contractor or to the town's collector, while 8 cities and 3 towns issue it to any person who satisfies the licensing board that he can transport the garbage properly. Information on this point is lacking from 5 cities and 4 towns.

As to the collection of garbage the general requirement is twice a week during the eight coldest months and three times a week during the remaining four months. Such extra collections from hotels and boarding houses are made as are deemed necessary. In the following 8 towns an extra assessment is made for the collection of garbage:

Mansfield.	Marion.
Duxbury.	Mattapoisett.
Easthampton.	Montague.
Hull.	Nantucket.

In Marshfield the town receives the money, while in the other towns mentioned the contractor is authorized to charge for collections and to retain the fees. In Duxbury the rate is approved by the board of health; the contractor has "what he can collect." In Hull the rate of 50 cents per week per family is approved by the board of health. In Marion, provided no resident objects, the contractor has what he can get. In Marshfield garbage tickets are issued at $1 per ticket per season, the town providing free tickets to hotels or large boarding houses. In Mattapoisett the rate fixed by the town authority is "not to exceed 50 cents per week for private families." In Montague the contractor "does as

he pleases; no fixed charge," and in Nantucket the board of health fixes the rates at "15 cents per day for private families, 75 cents per week for boarding houses, and from $15 to $35 during the summer months for hotels." Brookline, although making free collections, allows its contractor to charge such fees as he deems proper for visits aside from the regular collections.

While the regulations made by the towns and cities in this class relative to the disposal of garbage vary in accordance with the form of contract under which the garbage is collected, a few typical regulations are given below: —

Mattapoisett.

Form 1. — No person shall transport garbage or swill through the streets of the town of Mattapoisett without a license from the board of health.

Somerville.

Form 2. — No person shall remove or carry in or through any street, avenue, square, court, lane, place or alley, within the city, any house offal, or any offensive animal or vegetable substance, unless employed or authorized so to do by the board of health, nor in any manner except as authorized by said board.

Chicopee.

Form 3. — No person, unless expressly licensed therefor by the board of health, shall collect, transport or convey swill, offal or any decaying, putrefying or offensive animal or vegetable substance through any of the public streets or ways of the city. All vessels and wagons for the transportation of the above-named substances shall be made and kept in such condition as shall prevent the escape of any of their contents or the odor thereof; if any of the contents shall be spilled or fall upon any street, walk or premises, it shall be the duty of the keeper or driver to replace the same immediately and remove all traces thereof.

Cambridge.

Form 4. — All garbage shall be placed in suitable water-tight vessels, and shall be kept in some convenient place to be taken away by the city scavengers, and no ashes or other matter shall be mingled therewith.

The city scavengers are licensed to collect in covered wagons the contents of the vessels required in the preceding section. They shall remove all the contents of such vessels not less than twice each week, and from June 1 to October 1 not less than three times each week.

No person shall remove, or carry in or through any public or private way or place within the city, any decaying article of food, or any stinking or offensive matter, or any house dirt, garbage, manure, grease or bones, or any refuse substances from any of the dwelling houses or stables in the city, except in accordance with a license from the board of health.

The licenses referred to in the preceding section shall terminate on the first

day of April in each year. They shall be upon the following conditions, viz.: that

(1) All vehicles and vessels used by the licensee in such business shall be so constructed and maintained as to prevent the escape of any of their contents, and shall be kept tightly covered. All such vehicles and vessels shall be at all times subject to inspection by the board of health and its officers.

(2) Every such vehicle shall have the initials of the owner, and number of the license, in letters and figures two inches in height painted on the outside of each side.

(3) When the holder of the license discontinues the business for which it is granted, he shall return his license to this office.

(4) This license is revocable by the board of health at any time.

The form used by the city of Cambridge shows the specific conditions under which a permit is issued. In many cities and towns these specific conditions are printed upon the permit itself. In a few cities and towns, on the other hand, it was found that the requirement of a permit for the transportation of garbage was not enforced.

Terms of Contracts for the Collection, Transportation and Disposal of Garbage.

Following are the principal features of the varying forms of contracts for the collection, transportation and removal of garbage. It will be seen that in a few towns there is no signed contract, but merely an authorization to one person to collect the town's swill.

In 14 cities and 26 towns the contractor is paid by the city or town, and is allowed the collected garbage for his own disposal. In 1 city, Boston, and in 7 towns the contractor is paid for collecting the garbage, which must be disposed of in other ways than for his personal benefit. In 1 city and 2 towns the contractor pays the city or town for the privilege of collecting garbage, which he may sell or use for his own purposes. In 3 towns exclusive privilege is given to one or several collectors, who have the garbage and collect fees from householders. In the city of Beverly one contractor pays for the privilege of collecting garbage from two wards, while the city pays a second contractor to collect the balance. In each case the garbage is sold or used by the contractor.

Of the cities and towns which have contracts for the collection of garbage, 5 cities and 14 towns permit individual householders to take care of their own garbage, provided it is properly done, while 9 cities and 17 towns deny householders this privilege. Information on this point is lacking from 3 cities and 6 towns. In some cities the privilege of removing garbage is limited to hotels and restaurants.

Following is a list of the towns and cities which enter into contracts for the collection and disposal of garbage: —

Adams, . . One thousand dollars per year is provided for paying the contractor; town has garbage, feeds it to swine and sells the pork.

Athol, . . . Town pays one man $3 per day, two days per week; town has swill.

Belmont, . . Town pays contractor $500 per year to collect once a week in winter, twice a week in summer; contractor has the garbage.

Beverly, . . One contractor pays city $100 per year to collect two wards and he has garbage. City pays second contractor $5,150 for three years to collect balance; contractor has garbage.

Boston, . . Sanitary department collects much and turns it over to reducing company, the New England Sanitary Product Company. In Brighton, Dorchester, East Boston and West Roxbury four contractors collect the garbage; the Dorchester contractor delivers it to aforesaid rendering company, but the three others feed to swine. City pays rendering company $52,400 per year for receiving the garbage; it pays the four contractors, combined, approximately $1,500 per month and furnishes them with wagons, but contractors provide men and horses.

Braintree, . . Contractor receives $100 per year and the garbage.

Brookline, . . Contractor receives $6,250 per year and the garbage.

Chelsea, . . Contractor receives $400 per year and the garbage.

Chicopee, . . Contractor receives $250 per year and the garbage.

Clinton, . . Contractor receives $400 per year and the garbage; bi-weekly collections.

Dedham, . . Contractor is bonded; bi-weekly collections eight months, tri-weekly in four warm months; contractor has garbage. Amount of money expended not stated.

Duxbury, . . No written contract; town gives exclusive privilege to one person, who charges fee for collections; has garbage and buries it.

Easthampton, . Exclusive privilege is granted to one person, who has the garbage, but no pay.

Everett, . . Contractor receives $2,700 per year, and the garbage; collects twice a week for eight months, three times a week for four.

Fall River, . . Contractor receives a five-year contract for $44,900. Contractor has garbage and must dispose of it outside city limits; collects bi-weekly for eight months, tri-weekly for four months; hotels, restaurants, boarding houses, markets, fish markets, daily.

Fitchburg, .	. Amount of money appropriated and terms not stated.
Framingham,	. Town lets out contract to four men, who have the garbage and feed it to swine. Amount expended not stated.
Gardner, .	. Contractor receives $1,800 and the garbage.
Greenfield, .	. Contractor receives $1,000 per year and the garbage.
Haverhill, .	. Contractor has the garbage and some pay.
Holyoke, .	. Contractor receives $1,750 per year and the swill.
Hull, . .	. Contractor receives nothing from town, but is authorized to charge 50 cents per week per family. He does not have the garbage, but delivers it at wharf, whence it is taken to sea and dumped; for use of tug and scow the town pays $3,000 per year; collections only from April 15 to October 15.
Leominster,	. Contractor receives $1,000 per year and the garbage, which is fed to swine, and the use of a farm owned by the town; also the use of three teams.
Longmeadow,	. Verbal contract. Contractor receives $40 per year for collecting from a part of the town, and the garbage, which he feeds to swine.
Marion, .	. Contractor receives the garbage and charges what he can collect, but if objection is made is instructed to charge nothing.
Marshfield, .	. One man receives contract for unstated amount; collections mostly from summer cottagers; town issues "garbage tickets" at $1 per ticket per season, which entitles holder to services of contractor; hotels are given free tickets; town has receipts from sale of "tickets;" garbage is buried.
Mattapoisett,	. Contractor pays town $135 per year, and agrees to collect daily from all householders who pay a sum not exceeding 50 cents per week in the village; garbage is buried.
Maynard, .	. The lowest bidder now receives $75 per year for exclusive right; contractor has garbage, which is fed to swine.
Melrose, .	. Contractor receives $1,300 per year for bi-weekly collections. He has the garbage and feeds it to swine.
Middleborough,	. A contractor has been collecting the garbage for what he could get for it.
Milton, .	. The lowest bidder receives the contract and disposes of the garbage as he wishes.
Montague, .	. One person is authorized to collect the garbage and to charge what he pleases; no fixed rates; he feeds the garbage to swine.
Nahant, .	. Contractor is paid from board of health appropriation; contract gives him the garbage and requires him to dispose of it beyond the limits of the town.

Nantucket, .	. No money paid to contractor, who is an exclusive collector appointed by the town; he has garbage and must dispose of it in a manner satisfactory to the board of health; his fees, fixed by town, are 15 cents per day from private families, 75 cents per week from boarding houses, and from $15 to $35 per season during the summer months from hotels, according to their size.
Natick, .	. Contract price is based upon price to be paid to the town for the swill, determined by bids.
New Bedford,	. Contract is made with one person for term of ten years at the price of $23,500 per year, with additional $2,000 per year to collect night soil; contractor must collect all garbage, also all dead animals, and must kill same when requested; contractor has all garbage, and disposes of it at reduction plant.
Newburyport,	. City lets to contractor, who sublets to several persons, who feed the garbage to swine. Expense not stated.
Newton, .	. City bids it out on three-year contract, amount not stated; contractor feeds it to swine.
North Adams,	. Board of health lets contract for five years; pays $2,700 this year to one contractor, who may sublet if he chooses; he has garbage and it is fed to swine.
Northampton,	. City pays $850 per year to one contractor, who has garbage.
Norwood, .	. Town pays $250 annually, and the contractor has the garbage.
Oak Bluffs, .	. Contractor is paid an unstated sum to collect in June, July, August and September only. Contractor has garbage and buries it.
Orange, .	. One man receives $100 and the garbage.
Pittsfield, .	. Board of health makes contract, which shall be approved by the city government; amount not stated; contractor has the collected garbage.
Quincy, .	. Contractor pays the city $425 per year for all garbage collected in two wards; not stated as to other wards. He sells it to be fed to swine.
Revere, .	. Town pays $2,550 per year for collection of garbage and clam shells; contractor has garbage and shells; garbage is fed to swine.
Salisbury, .	. One contractor is paid an unstated sum for removing garbage at Salisbury beach only; garbage placed on dump.
Saugus, .	. Contractor is paid an unstated sum and has the garbage; he feeds it to swine.
Swampscott,	. Contractor is paid an unstated sum; receives the garbage and feeds it to swine.

Watertown, . Three thousand two hundred and thirty-seven dollars is paid for the collection of garbage (and ashes); the town has the garbage, and sells it to the highest bidder, receiving this year $1,250; buyer feeds it to swine.

West Springfield, Present contractor is paid $564 per year, and town takes care of the teams; contractor has the garbage, which is fed to swine.

Wellesley, . . The town has been collecting the garbage, which was fed to pigs. An appropriation is about to be raised for entering into a contract with some person for the collection and disposal of garbage.

Westfield, . . Eight hundred and fifty dollars per year is paid to contractor, who is given the garbage; he sublets to numerous collectors, who feed the garbage to swine.

Winthrop, . . Contractor is paid an unstated amount and has the garbage, which he feeds to swine.

Woburn, . . Contractor is paid $300 per year for collecting from thickly settled portions only; he has the garbage and feeds it to swine.

Methods of Garbage Disposal by Cities and Towns.

Two cities, Boston and New Bedford, dispose of garbage by the reduction method, although Boston disposes of a small part by feeding it to swine.[1] In 28 cities and 33 towns garbage is fed to swine. In 5 towns it is buried or plowed into the soil. In 3, Amesbury, Orange and Salisbury, it is disposed of on a dump. One town, Hull, puts it into the sea, and 1 city, Lynn, sells a portion to be fed to swine, and dumps the balance into the sea.

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[1] Two cities, Cambridge and Lowell, dispose of a part of the garbage by incineration.

MEDICAL AND SURGICAL APPLIANCES IN FACTORIES.

In 1907 the following act was passed relative to keeping medical and surgical appliances in factories (chapter 164, Acts of 1907, amended by section 104, chapter 514 of the Acts of 1909): —

Every person, firm or corporation operating a factory or shop in which machinery is used for any manufacturing or other purpose except for elevators, or for heating or hoisting apparatus, shall at all times keep and maintain, free of expense to the employees, such a medical and surgical chest as shall be required by the board of health of the city or town where such machinery is used, containing plasters, bandages, absorbent cotton, gauze, and all other necessary medicines, instruments and other appliances for the treatment of persons injured or taken ill upon the premises. A person, firm or corporation violating any provision of this section shall be punished by a fine of not less than five dollars nor more than five hundred dollars for every week during which such violation continues.

As the result of an inquiry in regard to the requirements of local health authorities in accordance with the section quoted above, the following data were obtained: —

Of the 354 towns and cities in the State 106 were found to contain no factories or shops to which the law applied. Some requirements were made by the boards of health of 156 towns or cities. The remaining 92 had either made some sort of requirement, the details of which were not reported, or had failed to make any report whatever. Owing to the fact that one particular outfit had been introduced into the factories in 32 towns or cities, the local boards of health made no further requirement.

The outfits required by 156 towns and cities may be classified as follows: —

Those requiring an outfit put up by a particular firm, or the equivalent of the same,	67
Those having miscellaneous outfits, 10 of which were insufficient or inadequate,	89

It was found that, as a rule, the towns required too many articles, often omitting essentials and putting in their place articles which should

not properly be included in a first-aid outfit. The following examples of proprietary preparations included may be cited: —

Recroso ointment.	Kresol.
Kapsikar embrocation.	Thyptus.
Camphenol.	Hydrochloxide.
Capsicol.	Encapor ointment.
Unguentine.	Miles's pain pills.
Phenol sodique.	

Other non-essentials found were: —

Arnica.	Witch hazel.
Ergot.	Antipyrin.
Aconite.	Liniment, etc.
Quinine.	

Only in a few instances was there an attempt at uniformity in regulating the size and nature of the outfit to the number of operatives in a factory or to the industry or occupation. A man who employed a dozen men was often compelled to provide the same outfit as one employing a thousand operatives, and it appeared to be more or less of a hardship for the small manufacturers to buy such extensive outfits as were on the market and required by some of the local officials. The same was true of the requirements of other towns, which demanded an equivalent outfit. After the law was passed the large cities made the first requirements, as a rule; then the smaller cities and adjacent towns made the same or nearly the same. In some instances, in the smaller towns, a local physician was consulted as to the preparation of a suitable outfit, and in other instances local druggists prepared an outfit which not infrequently contained various proprietary articles. Only a few towns required a practical, simple outfit, containing essentials without unnecessary articles. It seemed apparent that the meaning of the law was misunderstood, and its value consequently greatly lessened.

A first-aid outfit should contain the necessary articles for first dressing an injury. As a rule, the dressing is applied by a layman to protect the wound and to make the patient comfortable until a physician arrives, or until the patient is sent to a physician or to a hospital. It should be simply a temporary dressing, which may be readily and promptly removed by the physician who has charge of the patient.

From a careful study of the various first-aid outfits now in use, coupled with practical knowledge such as that gained by extensive hospital emergency work, the following list of articles is recommended for requirement by the local health authorities throughout the Commonwealth: —

First-aid packages,[1] sterilized, such as are used in the army and navy (one or more).

Gauze bandages (4 inches, 3 inches and 2 inches, — at least 2 of each).

Sterile gauze in yard packages (3 or 4 packages).

Sheet wadding (one piece).

Canton flannel (1 yard).

Safety pins.

Tourniquet (rubber tubing 24 inches by $\frac{1}{4}$ inch or $\frac{1}{2}$ inch).

Splint wood.

Zinc oxide adhesive plaster (1 10-yard roll 2 inches wide).

Forceps (1 pair).

Scissors (1 pair).

Boric acid ointment (tube).

Aromatic spirits of ammonia (1 ounce).

Antiseptic (an antiseptic accepted generally by the medical profession, either in solution or tablet form).

One basin.

The above articles should be inclosed in a dust and water proof case. Such articles as are removed at any time from the outfit should be replenished immediately.

Obviously, with such an outfit there should be a few first-aid rules.[2] For example: a physician should be sent for at once. Mere onlookers should be kept back and the patient given plenty of air. The patient should be disturbed as little as possible. Stimulants should be administered only with the knowledge and consent of a physician. In many cases they do positive harm, especially where there has been any bleeding. When dressing a wound one should use care not to handle that part of the dressing which is to be applied to the wound. The sole object of the first-aid dressing is to keep dirt from getting into the wound, which should not be touched with the fingers and handkerchief, or with anything else but the first-aid dressing moistened in the antiseptic solution. Dry gauze, cotton or any other substance should never be applied to an open wound. A sick or injured person should always be made to lie down on his back, if practicable, as in this position the patient is com-

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[1] A first-aid dressing which was prepared under the direction of the Massachusetts Humane Society is well suited for civilian accidents. It is described as follows: the first-aid package consists of several layers of surgical gauze sewed to a wide, firm bandage of unbleached cotton. The gauze is folded in such a way that it makes either a small dressing, or, when unfolded, will cover an area 7 inches square. The size of the gauze is larger than that supplied in the army and navy (where bullet wounds predominate), that it may cover, satisfactorily, the large wound of a compound fracture. The unbleached cotton bandage is rolled in such a way that the pad can be applied to the wound and the cotton bandage fastened around the limb without touching the sterilized gauze. Each package is covered with a piece of cotton cloth, sterilized and then done up in paraffin paper.

[2] *Cf.* "Manual for Privates of Infantry of the Organized Militia of the United States," by Capt. M. C. Kerth; also "American National Red Cross Text-book on First-aid and Relief Columns," by Maj. Charles Lynch.

fortable and the muscles are relaxed. If the face is flushed the head may be raised sufficiently to put a folded coat or small piece of clothing under it. If it is pale it should be kept low. If the patient vomits, his head or both head and body should be turned to one side, so that the matter vomited will not choke him. Tight clothing should be loosened, so as not to interfere with breathing or the circulation of the blood. In case of injury, the heart action is generally weak from shock, and the body grows somewhat cold, so that only such clothing as is necessary to expose the injury should be removed. Clothing may be cut or ripped but never pulled.

In the treatment of fractures it is important to prevent further injury and to keep the wound clean. Neither limb nor patient should be moved more than is absolutely necessary. If it is necessary to move the patient the fractured limb should first be immobilized by splints of some kind, as, for example, a cane, umbrella or piece of wood from a box.

Bleeding from a Wound. — If the blood comes in spurts it can be controlled by a piece of rubber tubing (tourniquet), tied nearer to the heart than to the injury, and placed as tight as possible about the limb. A tourniquet may cause pain and swelling of the limb, and if left on too long may cause the limb to die. The bandage should be loosened, therefore, very carefully every half hour or so, and if the bleeding continues pressure must be applied again. Bleeding from a wound may be controlled by direct pressure on the wound, which must first be covered with a piece of gauze which has been moistened in an antiseptic solution. For burns, a piece of Canton flannel may be covered with boric acid ointment and applied.

It would be advisable to accompany the paper or card containing rules and instructions by pictures and diagrams, to show methods of applying the tourniquet for hemorrhage and to illustrate artificial respiration.

Of the 156 towns and cities which made different requirements in accordance with the law, one or more essential articles were omitted, as follows: no antiseptic was provided in 96 outfits; no tourniquet in 34; no scissors in 26; and no stimulants in 13. In only 7 instances were bottles properly labelled; in only 14 outfits was there a basin; and a book of instructions was lacking in 112 outfits. Many of the towns omitted more than one of the essentials of the first-aid outfit, whereas 1 town, requiring only bandages, cotton, sticking plaster and liniment, omitted seven necessary articles.

An attempt was made to determine the various kinds of accidents or injuries which necessitated a first-aid outfit. Such accidents may be classified as follows: (1) abrasions; (2) cuts: (*a*) with hemorrhage; (*b*) without hemorrhage; (3) fractures; (4) asphyxiation; for example,

from fumes, gases, etc.; (5) burns. It is believed that all accidents or injuries that may occur in a factory are included under these five classes, and that the outfit suggested is sufficient to take care of any injury, provided a proper card of instructions is included. The outfit should be regarded as the minimum requirement or a unit, and if promptly replenished will be sufficient for any factory. If the establishment is a large one, where, owing to the industry or occupation, accidents occur frequently, the supply of gauze or bandages may be increased, or several outfits may be provided. Similarly, if burns are a frequent type of accident, the supply of Canton flannel and boric acid ointment may be increased, etc. It was found that several large factories maintained accident rooms under the charge of a surgeon, nurse or some one instructed in first-aid principles, and that the equipment in such rooms included the essentials of a minor surgery clinic, in addition to a supply of crutches, cots, stretchers, blankets, pillows, etc. While such an accident room in, or connected with, a factory is of great service to both employer and employee, its equipment should not be taken as a basis for making a list of first-aid requirements to be adopted by any local community in the enforement of the law relative to medical and surgical appliances.

OUTBREAKS OF INFECTIVE DISEASES.

Accounts of extensive outbreaks of infective diseases which have been investigated by State Inspectors of Health are recorded with those investigated by other agents of the Board in another portion of the annual report.

INDEX.

INDEX.